THE Petroleum Engineer

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20th Anniversary
● The story of Halliburton is a story of the American system in action...Our business started with nothing more than an idea...The idea, tested with borrowed horse-drawn equipment, proved so sound that out of it grew other ideas geared to a common objective: the scientific discovery and production of a vital commodity...In observing our 20th anniversary as a corporation, we pay humble tribute to the system of free enterprise that made possible our contribution to the welfare of the public and the well-being of the men and women who make up the Halliburton organization.
HALLIBURTON OIL WELL CEMENTING CO.
Duncan, Oklahoma

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JUL 26 1944

NEW DESIGN MAKES Wiggins Piston Balloon . . . more efficient than ever!

Operates at fraction-of-an-ounce pressure . . . may be used efficiently with existing cone-roof tanks that are not absolutely vapor tight.

THE new Wiggins piston balloon provides a means of reducing evaporation losses from groups of existing fixed-roof storage tanks. It consists of a steel tank or shell with a cone roof, inside of which there is a counterweighted piston that moves *down* and *up* as the gas flows in and out.

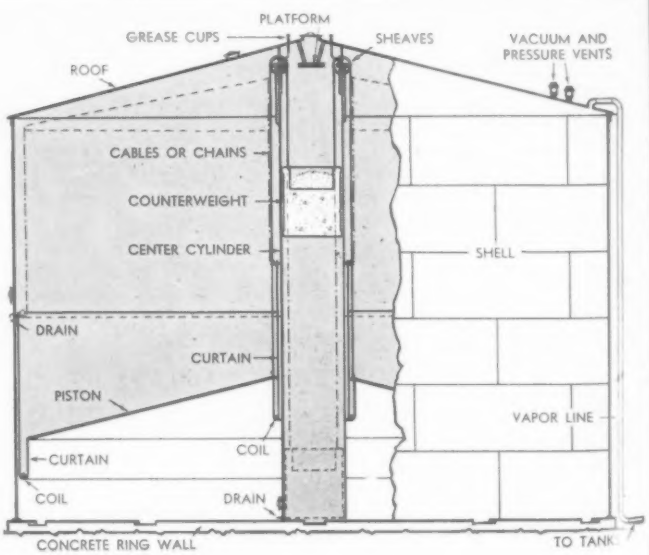
At the left is a photo of the new Wiggins piston balloon. It is a 150,000 cu. ft. installation located at an aviation gasoline plant. The unit is connected by piping to the vapor spaces of three 80,000-bbl., five 25,000-bbl. and five 10,000-bbl. tanks storing finished aviation gasoline. The system operates on the basic principle that no vapor loss will occur as long as vapor is not permitted to escape. The balloon has sufficient capacity to take care of all expansion in the vapor spaces in the tanks under normal operating conditions. When temperatures rise and the air vapor mixture above the surface expands, the excess flows through the vapor lines to the balloon. When temperatures fall, vapor is reabsorbed at the liquid surface and the contents of the balloon return to the tanks. Thus, breathing losses are prevented.

The new Wiggins piston balloon is equally efficient for both large and small installations. Write our nearest office for full details and complete information.

Seven of our plants have received the Army-Navy "E"
Birmingham, Ala., plant
Chicago, Ill., plant
Eureka, Calif., dry dock yards
Greenville, Pa., plant
Morgan City, La., dry dock yards
Newburgh, N. Y., dry dock yards
Seneca, Ill., ship yard

** The Wiggins piston balloon above serves thirteen tanks having a total capacity of 415,000 bbls. The interior view directly above shows the piston in high position. The gas storage space in the new design is above the piston instead of below it. This makes it possible to inspect the underside of the piston and the sealing curtains without taking the balloon out of service.*

** Right: Some of the construction features of the Wiggins piston balloon. The piston is approximately 1½ ft. less in diameter than the shell and is supported on a central cylindrical column by cables that pass over sheaves at the top of the column and attached to a counterweight on the inside. The space between the outer edge of the piston and the shell is closed by means of a flexible curtain or seal which is connected to the shell at mid-height and is long enough to permit the piston to travel to the top and bottom of the balloon. A similar curtain closes the space between the inner edge of the piston and the center cylinder.*



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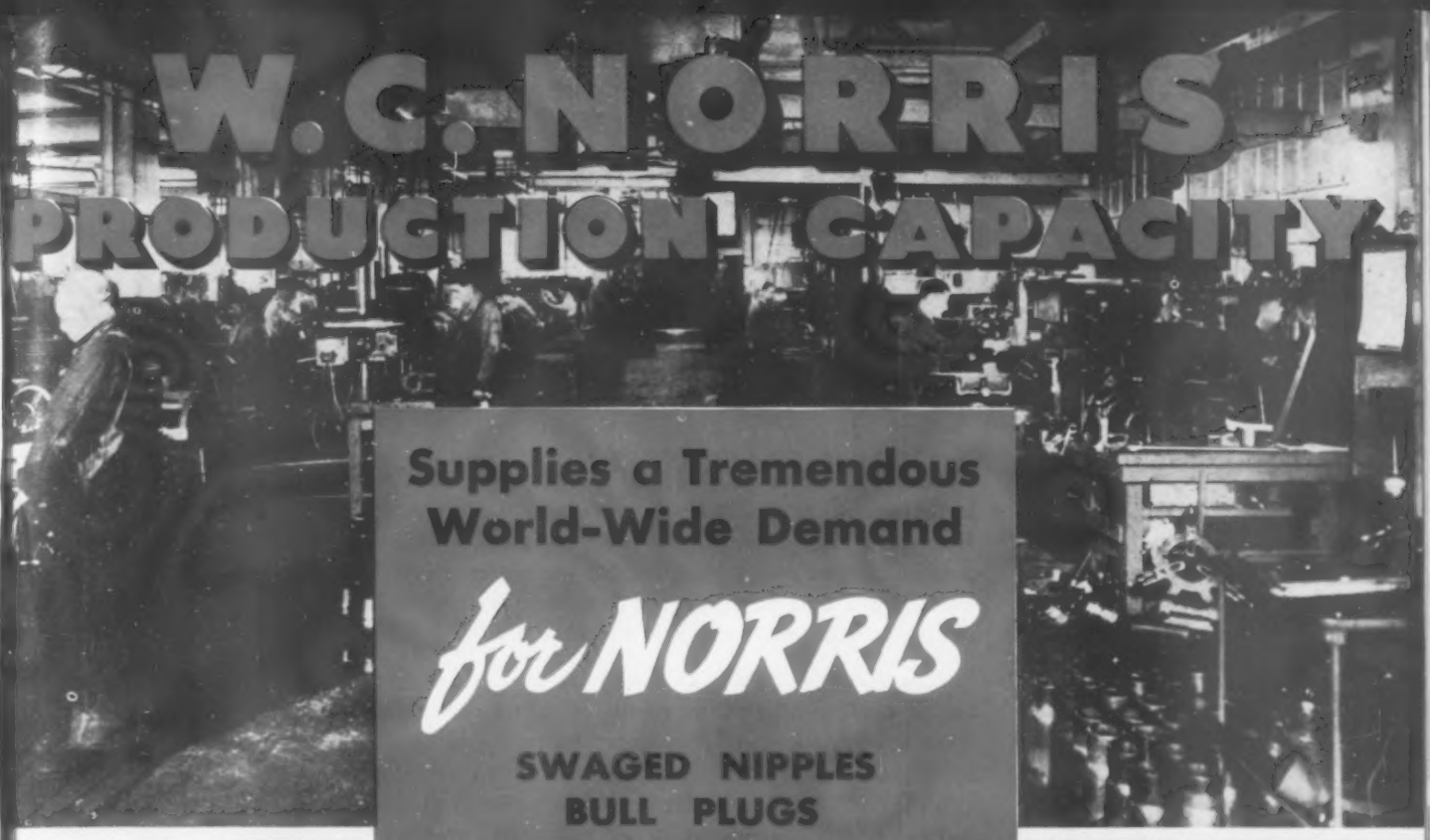

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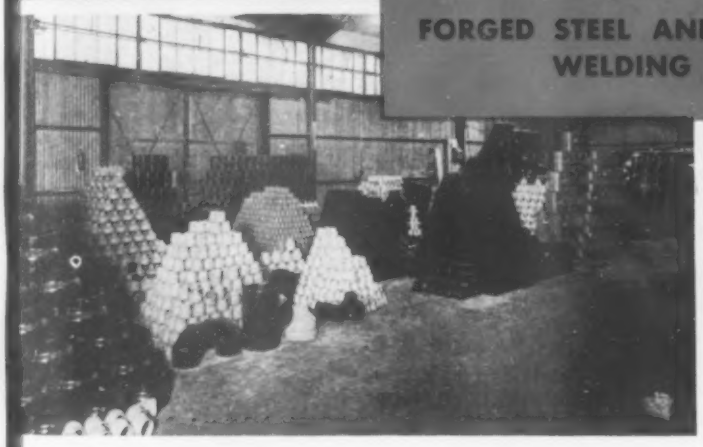

Despite an unprecedented demand on our production capacity in the manufacture of vital materiel of war, NORRIS Production capacity has been steadily increased until today, you need not accept less than NORRIS QUALITY in Swaged Nipples, Bull Plugs and Forged Steel Welding Reducers. For over half a century the name W. C. NORRIS and QUALITY have been synonymous in the manufacture of oil tools. Pioneering the exclusive NORRISIZING treatment for the elimination of rust and corrosion to prevent galling and seizing of threads, NORRIS Swaged Nipples, and Bull Plugs remain bright and new throughout their useful life at no extra cost over ordinary painted finishes. Be sure they're NORRIS—look for the label, then you can forget them. See your supply store. Send for descriptive Bulletin No. 31.

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The NORRIS method of forging furnishes 3 TIMES the wall thickness in the nose—extra strength, where it's needed most.
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Through the years, POWELL Engineering has not only met, but has actually anticipated the demands imposed by the amazing developments in the Oil Industry. That is why there's a POWELL Valve, correctly engineered in every detail, to meet every requirement for dependable flow control in the making of Butadienne and Styrene (for Synthetic Rubber), 100 Octane Gasoline, Toluol, Butane, Butylene, Ethylene and other base products.

Today—in the Nation's leading refineries—POWELL Valves are giving unfailing service in handling corrosive media such as hydrogen chloride in insomerization and diasopropyl plants; hydrofluoric acid, sulfuric acid and sodium hydroxide in alkylation plants; either erosive or corrosive media encountered in liquid and solid catalytic cracking, hydrogenation, dehydrogenation, polymerization or the regeneration of catalysts, and also in controlling flue gases and hydrocarbons in transfer lines.

And, remember, Powell Engineering is always at your service to help you solve any flow control problems with which you may be confronted.

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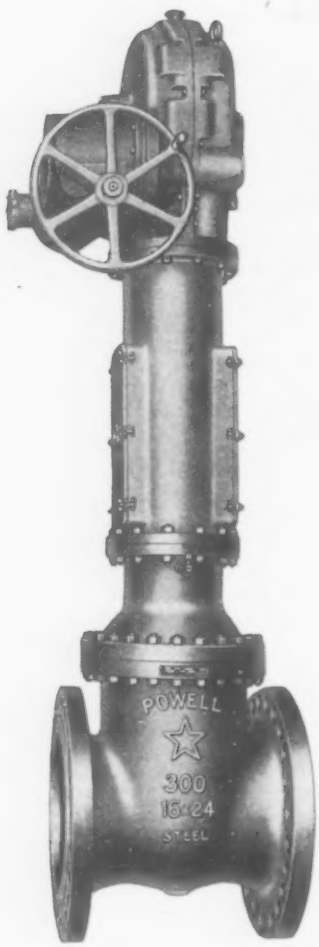


Fig. 3023 Mod.—Class 300 pound Cast Steel flanged end Gate Valve with Electric Motor Operator. Has 16" port size venturied to 24" pipe size end flanges to accommodate insulated pipe.

Fig. 190—Iron Body Bronze Mounted Globe Valve, with screwed ends, for 150 pounds W. S. P. Has regrindable, renewable "Powellium" nickel-bronze seat and disc.

Fig. 375—Bronze Gate Valve with screwed ends, for 200 pounds W. S. P. Has a renewable "Powellium" nickel-bronze disc.

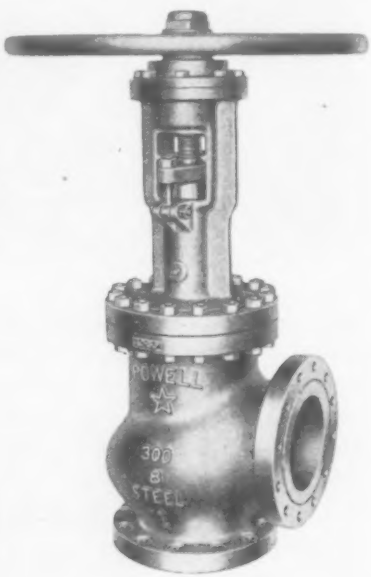
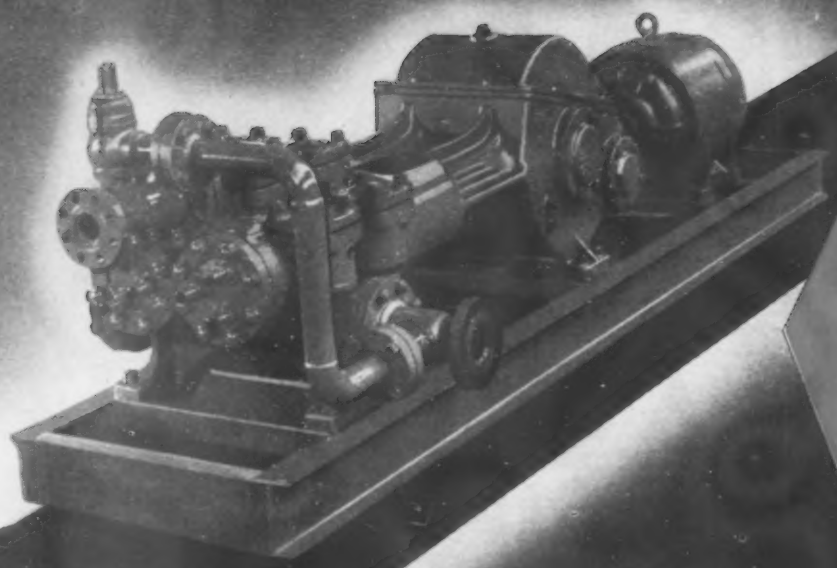


Fig. 3033—Class 300 pound Cast Steel flanged end O. S. & Y. Angle Valve with bolted flanged anti-friction bearing yoke. Adapted for high temperatures—up to 1400 F.

POWELL VALVES

WHEATLEY PUMPS *on the "Big Inch" Pipe Line*



From SUMP PUMP

(ABOVE)
2½" to 4" x 6" — DIRECT DRIVEN — FIG. No. 1324
DUPLEX — RECIPROCATING — DOUBLE ACTING
3" PISTONS — 68 B.P.H. @ 767 lbs. W.P.

To STATION STANDBY

W WHEATLEY

2½" to 4" x 6" — V-BELT DRIVEN — FIG. No. 4650
QUINTUPLEX — RECIPROCATING — DOUBLE ACTING
3½" PISTONS — 418 B.P.H. @ 765 lbs. W.P.

FRANK WHEATLEY PUMP & VALVE MFR.

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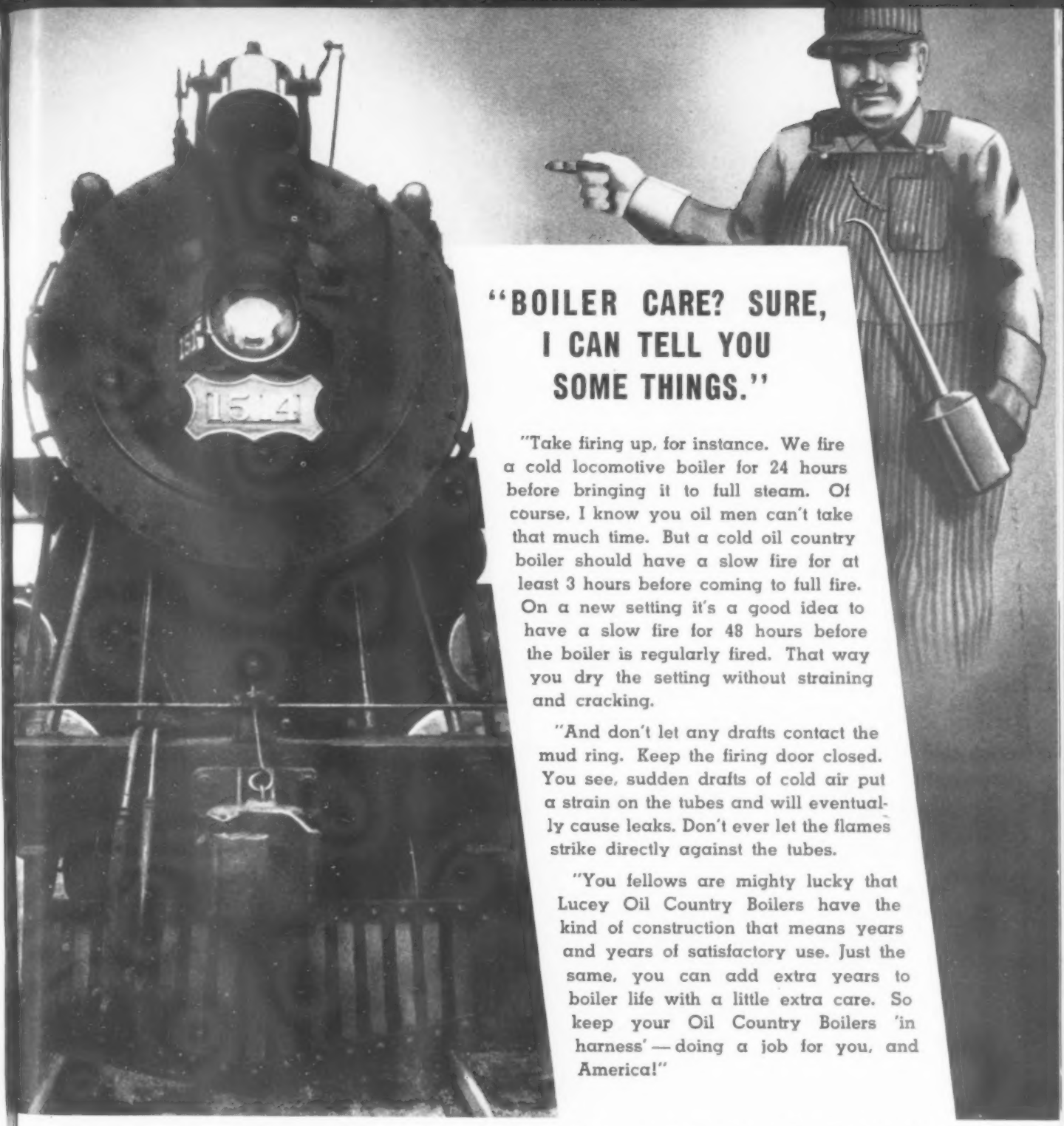
The Petroleum Engineer, published monthly, August through June, semi-monthly in July, by The Petroleum Engineer Publishing Company, seventh floo Irwin-Keasler Building, Dallas, Texas. Subscription price, $2.00 per year, $3.00 for 2 years, 25¢ a copy. Entered as second-class mail matter May 1, 1932, at th post office at Dallas, Texas, under the Act of March 3, 1879.

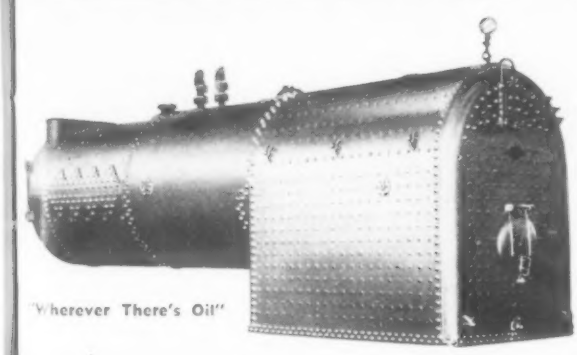


"BOILER CARE? SURE, I CAN TELL YOU SOME THINGS."

"Take firing up, for instance. We fire a cold locomotive boiler for 24 hours before bringing it to full steam. Of course, I know you oil men can't take that much time. But a cold oil country boiler should have a slow fire for at least 3 hours before coming to full fire. On a new setting it's a good idea to have a slow fire for 48 hours before the boiler is regularly fired. That way you dry the setting without straining and cracking.

"And don't let any drafts contact the mud ring. Keep the firing door closed. You see, sudden drafts of cold air put a strain on the tubes and will eventually cause leaks. Don't ever let the flames strike directly against the tubes.

"You fellows are mighty lucky that Lucey Oil Country Boilers have the kind of construction that means years and years of satisfactory use. Just the same, you can add extra years to boiler life with a little extra care. So keep your Oil Country Boilers 'in harness' — doing a job for you, and America!"



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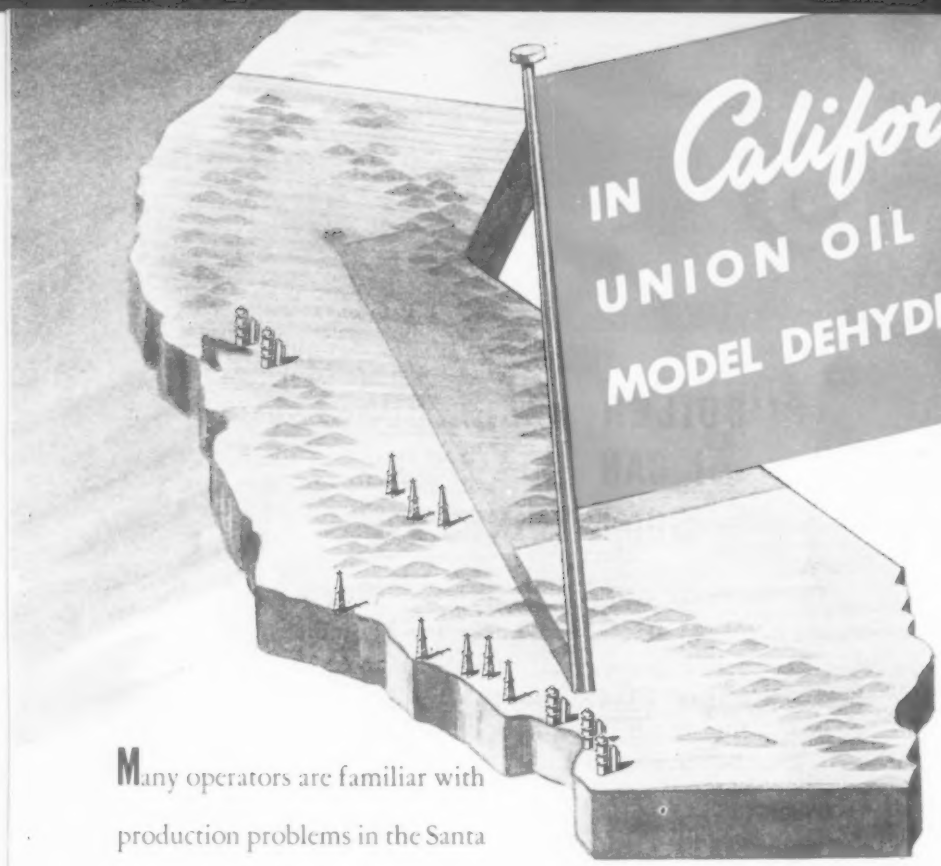
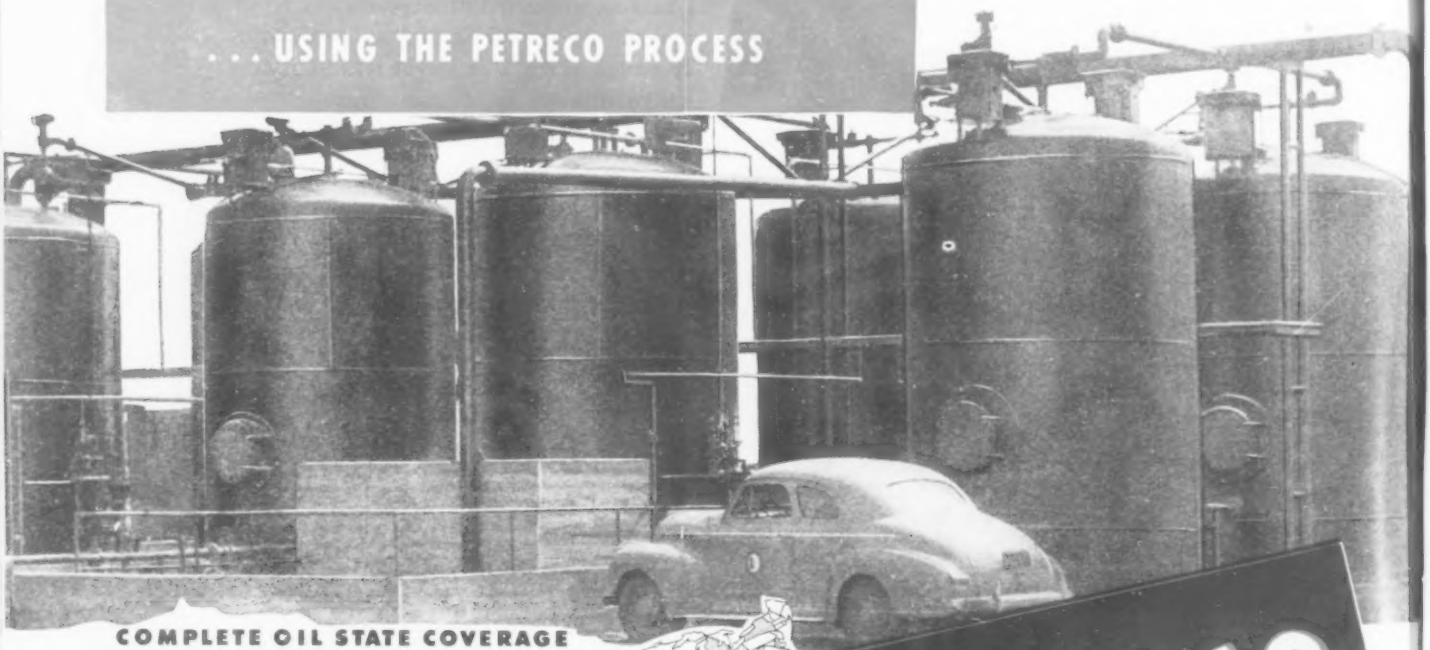


IN California UNION OIL INSTALLS A MODEL DEHYDRATION PLANT

Many operators are familiar with production problems in the Santa Maria, California, area, where operating techniques must be highly efficient to properly dehydrate the heavier, more viscous crudes. In this area, Petreco Electric Dehydrators are being utilized very effectively by the Union Oil Company.

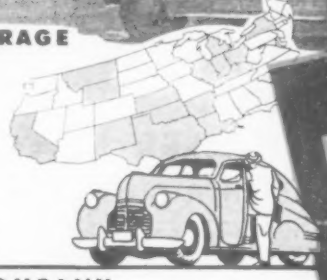
Petreco Dehydrating, while efficiently treating crudes over a wide range of gravity, was virtually "raised" on heavy oil. Now, with the heavy oils in constant demand, Petreco Electric Dehydrating is worth keeping in mind.

. . . USING THE PETRECO PROCESS



COMPLETE OIL STATE COVERAGE WITH PETRECO PROCESS

Resident field engineers are located in refining and producing centers wherever Petreco processes are in use. These men are specialists, and are always available to assure maximum operating efficiency, and to give helpful advice and assistance on any problem of dehydration or desalting.



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Representatives in principal production and refining centers

DEHYDRATING DESALTING

Now's the time to TAILOR THE PUMPING CYCLE TO FIT THE WELL

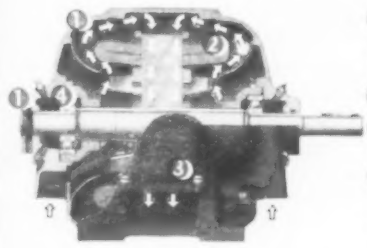
Whether your wells require rapid pumping for short intervals or slow pumping for long intervals, you can now operate them automatically.

With this G-E motor-and-starter team you simply preset the pumping cycle—by setting each well's self-timing G-E starter—to suit the individual requirements of the well. From then on, for months on end, the pump starts, runs, and stops automatically. You make available man-hours count for more. And—by "tailoring" the pumping cycle to fit the well, you make the well yield *more oil.*

To assure long life, G-E splashproof motors are built to withstand the severe vibration of oil-well service, and the rigors of outdoor life. Windings are of tough Formex* wire—no cotton wrappings to absorb moisture. They are bonded with moisture-resistant varnish and protected by a coat of Glyptal* for added defense against electrical breakdown.

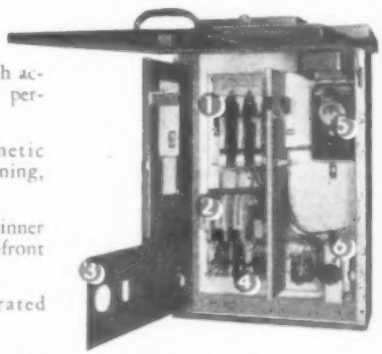
And remember that G-E application engineers are always near at hand to help solve your pumping and drilling problems. Call on them through your local office. *General Electric Company, Schenectady 5, N. Y.*

*Reg. U.S. Pat. Off.



1. One-piece cast-iron frame and deflecting end shields resist corrosion.
2. Cast-iron baffles.
3. Water-tight conduit box.
4. Seal along shaft excludes liquids from cast-iron enclosed ball bearings.

Cutaway view of G-E Tri-Clad* splashproof motor, showing how effective cooling is attained.



1. Motor-circuit switch accessible to authorized persons only.
2. Long-lived magnetic starter, with self-cleaning, self-aligning contacts.
3. Normally closed inner door provides dead-front panel.
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CR7008-A2KG Size 2 starter, with both lift and swing doors open.

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Where purchased power is not economically available, isolated engine-driven G-E generators and a simple G-E power distribution system will provide low-cost power.

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Buy all the BONDS you can — and *Keep all the Bonds You Buy*

MEETINGS

August 3—California Natural Gasoline Association, monthly meeting, Rio Hondo Golf Club, Downey, Calif.

September 11-15—American Chemical Society, fall meeting, Pennsylvania Hotel, New York, N. Y.

September 20-22—NPA, annual meeting, Hotel Claridge, Atlantic City, N. J.

October 2-5—American Society of Mechanical Engineers, fall meeting, Cincinnati, Ohio.

October 3-4—AAODC, annual meeting, Fort Worth, Texas.

October 3-5—National Safety Congress, Sherman, Morrison and La Salle hotels, Chicago, Ill.

October 5-6—American Gas Association, Stevens Hotel, Chicago, Ill.

October 12-13—Texas Mid-Continent Oil and Gas Association, Rice Hotel, Houston, Texas.

October 13—California Natural Gasoline Association, annual meeting, Biltmore Hotel, Los Angeles.

October 23-25—IPAA, annual meeting, Dallas, Texas.

November 9-10—Society of Automotive Engineers, National Fuel and Lubricants, Mayo Hotel, Tulsa, Okla.

November 13-16—API, annual meeting, Stevens Hotel, Chicago, Ill.

November 15-19—American Chemical Society, third national chemical exposition, Coliseum, Chicago, Ill.

January 8-12—Society of Automotive Engineers, annual meeting, Book-Cadillac Hotel, Detroit, Mich.

March 12-14, 1945—National Association of Corrosion Engineers, President Hotel, Kansas City, Mo.

★ ***Something new has been added by John H. Kunkel, refinery editor, in his article on the new Cities Service refinery at Lake Charles, Louisiana. The table, "Refinery Column Design Data," is the first of its kind to be published. It will enable refinery and design engineers to see at a glance an informative picture of the columns.***

★ R. G. Lovell, an outstanding petroleum engineer, writer, and teacher, and a frequent contributor to The Petroleum Engineer, died June 15 at his home in Long Beach, California. In 1920 he left mining to go into petroleum engineering, joining Standard Oil Company of California. For many years he was development engineer for Hancock Oil Company. He will be remembered as an experienced engineer who did his part in recording the oil industry's development at a crucial period.

THE Petroleum Engineer

July, 1944

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A MAGAZINE OF METHODS FOR OPERATING MEN

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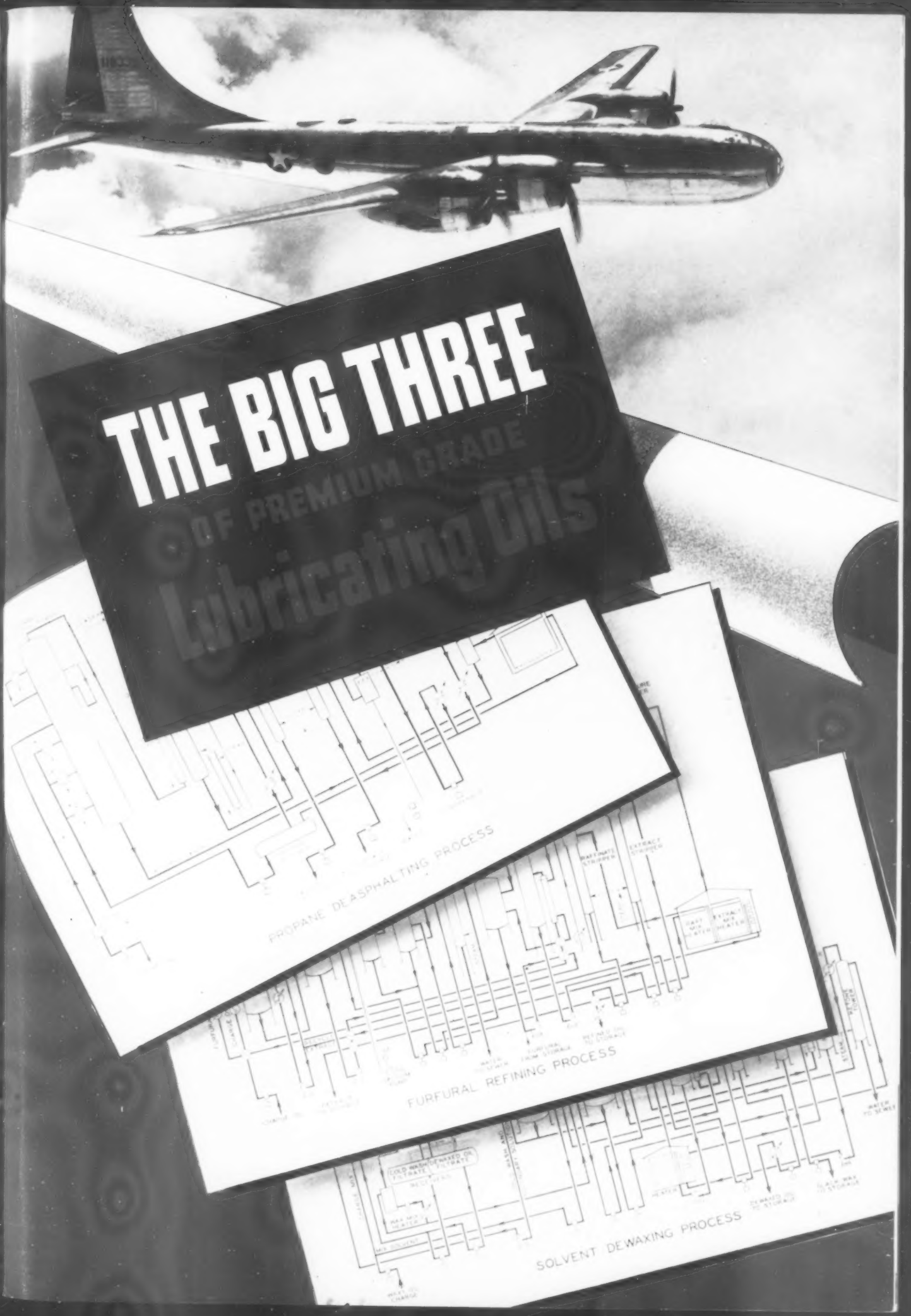
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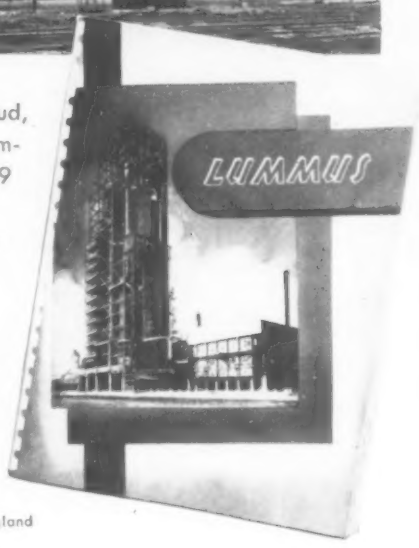

High yields . . . high viscosity index . . . low pour point with equivalent cloud, and good color characterize the quality lubricating oils produced by this combination of processes. Lummus has built 14 solvent refining plants, 19 solvent dewaxing units and several complete lube oil refineries.

For one major refiner, Lummus designed and built a Benzol-Ketone dewaxing unit within 20 weeks from signing of contract.

The latest refinements in Propane Deasphalting, Furfural Refining and Benzol-Ketone Dewaxing are described, with accompanying flow sheets, in the latest Lummus book, "Petroleum Refining Processes." This book contains much technical data, a number of installation photos and twenty-one flow diagrams of petroleum refining processes. If you do not have a copy, write for one.

THE LUMMUS COMPANY, 420 Lexington Ave., New York 17, N. Y.

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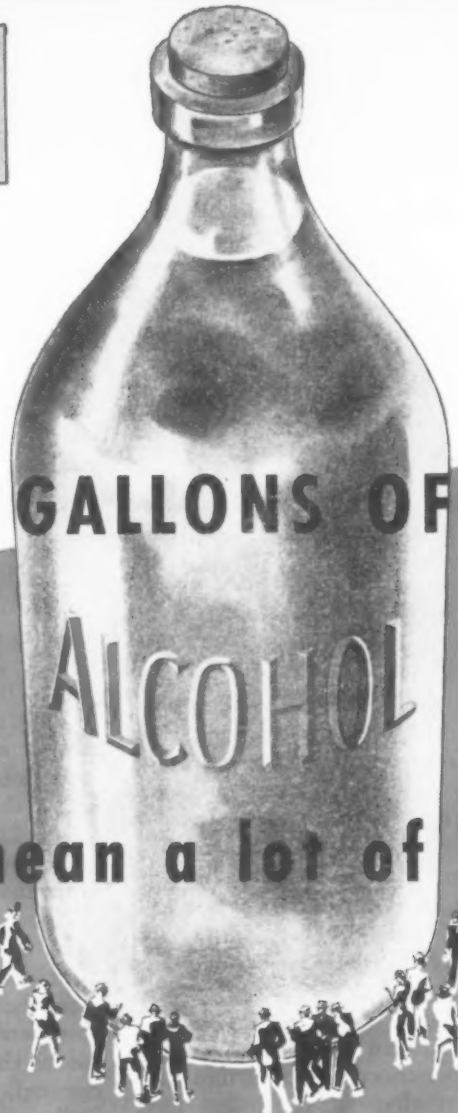
A finer, more abundant living
TODAY and TOMORROW
because of Petroleum Chemistry

110 MILLION GALLONS OF



could mean a lot of headaches

but to the Petroleum Chemist

it means another of the many important products derived from petroleum. It means ethyl, methyl, isopropyl, ethylene glycol and other alcohols for industrial, domestic and military needs.

Before Pearl Harbor, the annual output of ethyl alcohol in this country alone, was some 110 million gallons. War has upped the need for all alcohols and the oil industry is supplying a major portion of the total.

Uncle Sam demands quality! And quality depends greatly on clean crude, clear of emulsion. Here again, chemistry answers with Tret-O-lite, laboratory compounded for specific emulsion problems, providing efficient, economical and fast performance. Leading oil producers the world over, recognize Tret-O-lite's reliability and leadership in this field.

Oil field emulsions vary. Each requires individual analysis and treatment. That is why a competent Tret-O-lite field engineer is located convenient to each producing area. His recommendations are accurate and dependable.

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DEHYDRATING **DESALTING**

The Course of Oil

by K. C. SCLATER

MANPOWER FOR DRILLING

Drilling contractors have suffered more acutely from manpower difficulties than almost any other group in the oil industry. Since drilling restrictions were applied by PAW in 1942 they have lost many of their skilled men to the armed services or to other war industries. The problem was intensified when wage scale differentials, subsequently imposed by Federal order, went into effect. Now that restrictions are being relaxed and drilling activity is increasing, drilling contractors are hard pressed for skilled help.

The new WMC order controlling all manpower, went into effect July 1. What effect this order will have on obtaining satisfactory field help has been a matter of concern among drilling contractors. In this connection, A. H. Rowan, president of the American Association of Oilwell Drilling Contractors, took the matter up with the War Manpower Commission. WMC representatives from Dallas and Houston met in Houston with Rowan to discuss what might be done to remove hardships on operators engaged in drilling activities. A verbal agreement was reached allowing the transfer of men from one area to another while still in the employ of the same company; also, it was agreed that men may be hired on certificate of availability and without a referral slip if there is no U. S. employment service office in the county.

It was pointed out by Rowan that much of the manpower trouble now experienced in the drilling industry arises from the fact that WMC orders have been disregarded by some drilling contractors by their failing to require certificates of availability from the men they hire. This has been partly responsible for a large turnover in drilling labor and has led to inefficiency in drilling operations. This verbal agreement made between the WMC and the president, Rowan, of AAODC should aid in reducing manpower difficulties that confront drilling contractors.

STRIPPER WELL SUBSIDIES

Beginning August 1, stripper wells will be subsidized by the Federal Government. Subsidies will be on a sliding scale and will range from 20 cents a barrel in fields with wells averaging 7 or more but less than 9 barrels a day, to 75 cents a barrel for wells in Pennsylvania grade fields averaging about half a barrel a day. Such subsidies will keep some stripper wells on production and delay their abandonment, but they will not add a barrel of oil to the nation's reserves. Neither will they be an incentive for engaging in new secondary recovery operations because of the limited time the subsidy plan will be in effect.

Meanwhile, the industry is nearing the point when it will be obliged to draw on present producing fields at a rate that will impair their ultimate production in order to supply the increased war demand for oil. If the demand continues to increase at the present rate, the rate of withdrawal within a few months will be such as to reduce the ultimate production of many fields now producing efficiently and so bring about a heavy underground loss of oil in these fields. Washington officials responsible for denying a general increase in the price of crude oil seem to have ignored the fact that the available oil reserves of the nation are now threatened with further losses by being too heavily drawn on.

OIL MINING PROJECT

Within a few miles of the original Drake well near Titusville, an experimental shaft is being sunk for the production of oil by a modified mining method. This appears to be one of the most ambitious secondary recovery projects of its kind that has ever been undertaken. It may have a far-reaching influence on future producing operations in old shallow oil fields. If successful it will mean that the old Pennsylvania fields can look forward to still greater ultimate recoveries of oil that will lengthen the life of these fields many years. The project is being undertaken by the Northern Ordnance Company, a comparative newcomer in the oil industry.

The method of recovery will be different from that now in operation elsewhere in Pennsylvania, where a series of horizontal wells radially disposed are drilled into the formation from the bottom of a shaft. In this new project, the shaft will be sunk to a depth below the oil-producing formation and a tunnel excavated, from the roof of which a series of vertical wells will be drilled up into the oil formation.

No expense is being spared to give the method a thorough and fair test. The project is being carefully engineered. Its progress will bear watching.

EASING OF RESTRICTIONS

Deputy director of PAW, Ralph Davies, assured oil operators at Houston last month that the suggestions for modifying restrictions in PAO-11 put forward by the Production Committee of PAW District 3 would be taken under immediate consideration upon his return to Washington. Quick action was taken by Davies on the suggestions submitted, for on July 1st was issued supplementary order No. 12 to PAO-11. Federal restrictions are eased on the drilling of oil and gas wells in Arkansas, Louisiana, and Misssissippi. Restrictions are also removed on distance between wells and on distance between wells and property lines. Operators will still be governed by state regulations.

Another important easing of restrictions is concerned with the reworking, deepening, or recompletion of wells into another pool so that wells may be reworked under the same regulations governing the drilling of new wells. In the East Texas field pumping equipment may also be installed on one well to every ten producible acres or on any well on a lease on which the Railroad Commission of Texas permits the transfer of allowable production from one well to any other well located on the same lease.

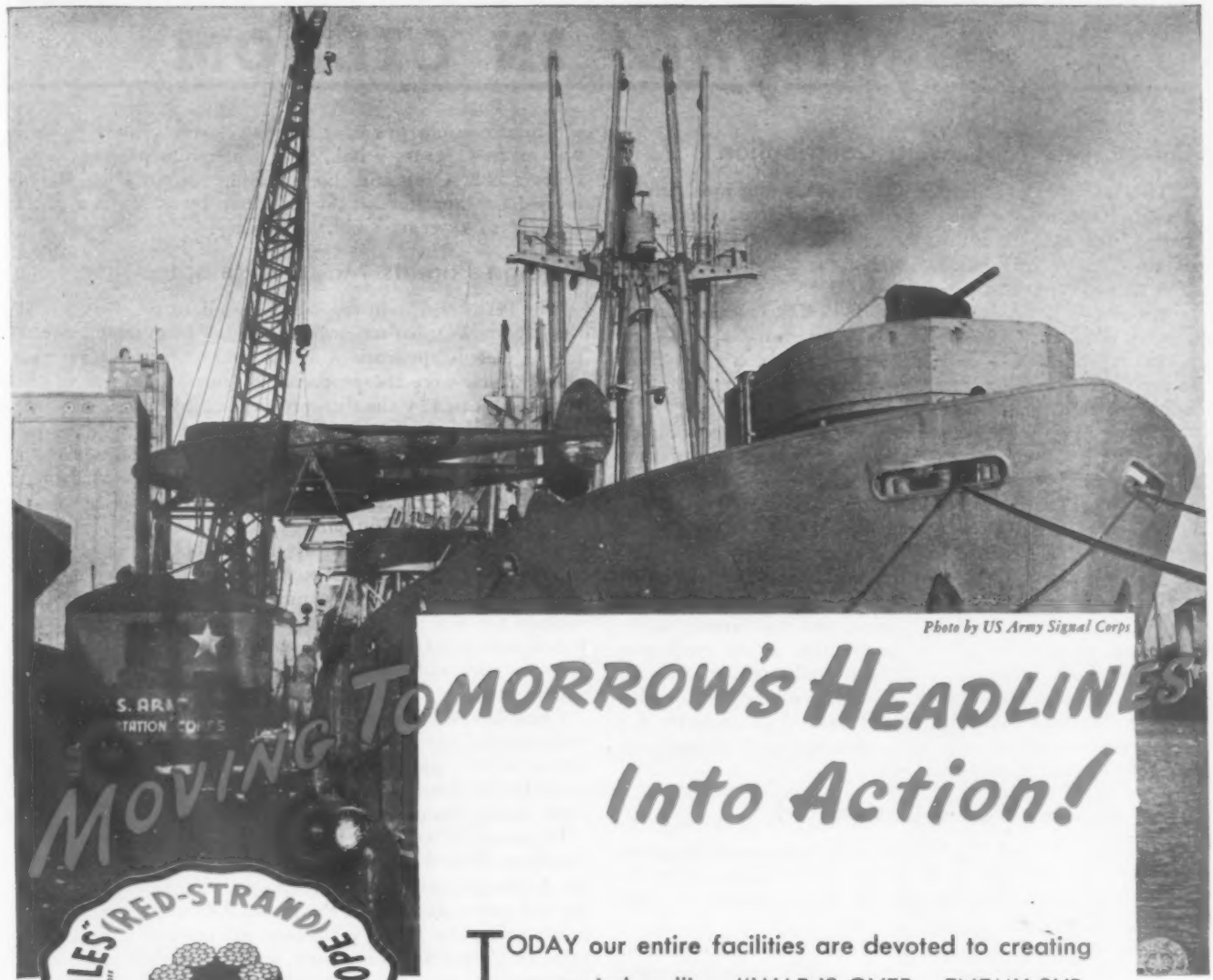

Photo by US Army Signal Corps

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Highlights IN OILDOM

Oil Industry Makes Big Contribution

Thus far the American oil industry has dug into its own pockets for nearly one billion dollars for construction and expansion of petroleum plants and facilities to expedite the exit of the Axis by Allied armed forces, the Petroleum Industry War Council announces.

William R. Boyd, Jr., chairman of PIWC, revealed that oil companies in the United States, as of January 1, 1944, reported expending $970,058,739.06 exclusively as a war effort in accelerating refining, marketing, and transportation channels of the war-geared petroleum industry.

This total, the PIWC chairman emphasized, reflects capital expenditures voluntarily made as an additional contribution to the successful progress of the war above and beyond any and all federal government funds that have been forthcoming in petroleum's part in the world conflict.

Chairman Boyd further explained that the near billion dollar war expenditure of the industry does not include the incalculable other millions of dollars spent by the companies for stepped-up exploration, development, and wildcatting activities made to assure petroleum production at the prodigious pace and in the quantities exacted by military and essential civilian requirements. Neither, he said, does the sum involve still other capital financings by the natural gas industry for such war-necessitated projects as gathering and transmission lines and natural gas wells.

Price Subsidy Pools Designated

The Office of Price Administration has designated the crude oil pools whose maximum prices may be increased under the premium payment plan announced by Economic Stabilization Director Fred Vinson.

Beginning August 1 increases of from 20 to 35 cents a bbl. are allowed for those groups listed, with a general increase of 75 cents a bbl. to pools producing Pennsylvania grade.

Crude oil produced at pools averaging less than 9 bbl. a well per day qualifies for the payments, which are estimated to cost the government approximately $55,000,000 a year.

Maximum prices of crude oil on sales other than those made by producers and owners of royalty interests are not increased, OPA said, because the plan provides for premium payments to first purchasers.

The additional payments are designed to keep in operation pools made up predominately of stripper or marginal wells or others averaging less than 9 bbl. daily.

All Pennsylvania grade crude wells qualify for the payments because they average about ½ bbl. daily.

Apart from Pennsylvania grade pools, payments are allowed as follows: Pools averaging less than 5 bbl. daily per well, 35 cents a bbl.; pools averaging between 5 and 7 bbl. daily per well, 25 cents a bbl.; pools averaging between 7 and 9 bbl. daily, 20 cents a bbl.

The 75 cents a bbl. bonus over ceiling prices allowed for Pennsylvania grade oil pools will affect Pennsylvania, New York, Ohio, and West Virginia.

Pools are allowed payment of 20 to 35 cents a bbl. over ceiling prices designated by OPA according to specific name or group in the states of Arkansas, Colorado, Illinois, Indiana, Kansas, Kentucky, Louisiana, Michigan, Missouri, Montana, Nebraska, New Mexico, Ohio, Oklahoma, Pennsylvania, Tennessee, Texas, and Wyoming.

OPA said no payments are permitted as premiums at this time in the oil-producing states of Alabama, California, Florida, Mississippi, Utah, and Virginia.

The maximum price for the Smackover field in Arkansas was made 83 cents a bbl., plus a premium payment of 20 cents a bbl., OPA said. For hardship reasons OPA had increased the Smackover field maximum by 15 cents a bbl. to bring it to 98 cents a bbl. in January.

Foreign Patents Made Available

The Petroleum Industry War Council, in cooperation with the government, has stripped the secrecy from more than 100 foreign patent applications in the field of petroleum science, all of which were the properties of enemy aliens until they were confiscated by the alien property custodian.

With their specifications originating in Germany, Japan, and occupied countries, these abstracts of advancements in petroleum technology cover material hitherto unavailable to the public and are patent applications sent to the United States from enemy sources but unfiled officially or abandoned altogether for unknown reasons by their authors.

They were selected by a picked group of scientists of the petroleum industry at the request of the Petroleum Administration for War with the sanction of the alien property custodian because of the belief they might prove of value to the industry and public in this country in the war effort and the postwar era.

Chairman William R. Boyd, Jr., of PIWC, revealed that these specific petroleum inventions planned by the enemy were chosen after a prolonged and painstaking process from 800 unfiled miscellaneous Axis patent applications and more than 3000 similar abandoned patent applications.

In pursuit of its policy that patents and related material of enemy origin now vested in the custodian be made available to the American people, the alien property custodian's office requested cooperation of the Petroleum Administration for War in screening the seized petroleum patents for their possible value to United States industry, science, and invention in the fast-moving progress of petroleum technology. Because PAW manpower problems prohibited that agency's engaging in the exacting study of the confiscated patent applications, PAW obtained the alien property custodian's consent to enlist the aid of a special panel of petroleum industry scientists to do the job. The industry's response came with the technical advisory committee, a subcommittee of PIWC's technical committee, accepting the task.

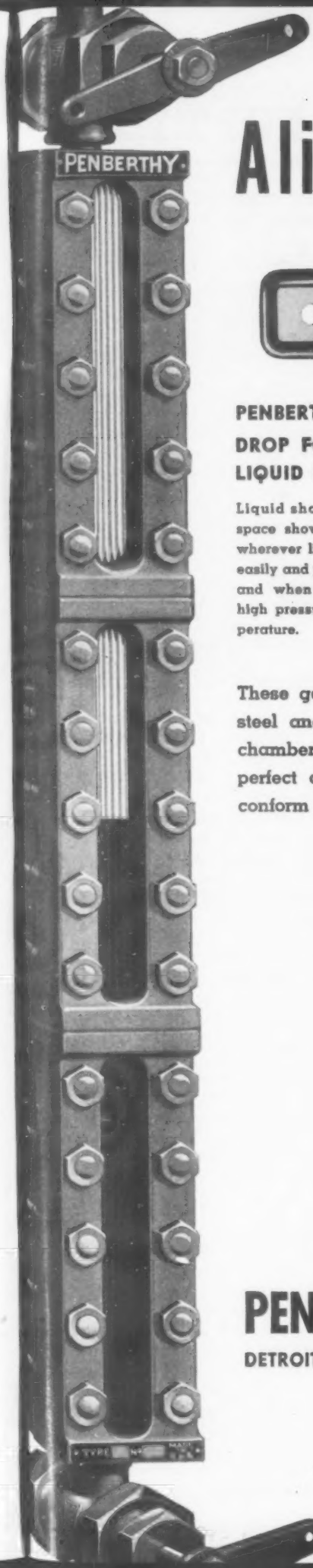
The industry's special study group consisted of Louis D. Forward, of the Sinclair Refining Company, Harold V. Atwell, The Texas Company, and Myron J. Burkhard, Socony-Vacuum Oil Company, Inc. This group worked in close cooperation with A. E. Miller, secretary of the technical advisory committee, and under the general guidance of Dr. T. G. Delbridge, chairman of the T. A. C.

Anniversary Meeting IPAA

Preliminary plans for the fifteenth anniversary meeting of the Independent Petroleum Association of America, to be held in Dallas, Texas, October 23, 24, and 25, were outlined recently by members and directors at a meeting in Dallas.

Heading the general arrangements committee are Harry Moss and Gilbert P. Moore of Dallas.

Dallas oil men named co-chairmen of the various sub-committees included W. P. Luse and Ray Hubbard, attendance and publicity; Walter Lechner and O. G. Leichliter, reception; Dilworth S. Hager and W. L. Pickens, finance; R. S. McFarland and Jay Simmons, entertainment; Haynes B. Ownby and H. P. Taubman, reservation, and Dr. J. C. Karcher and C. R. Rider, transportation.



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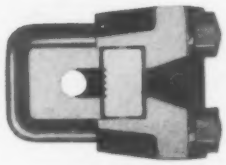

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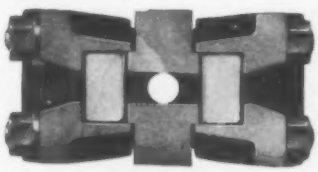

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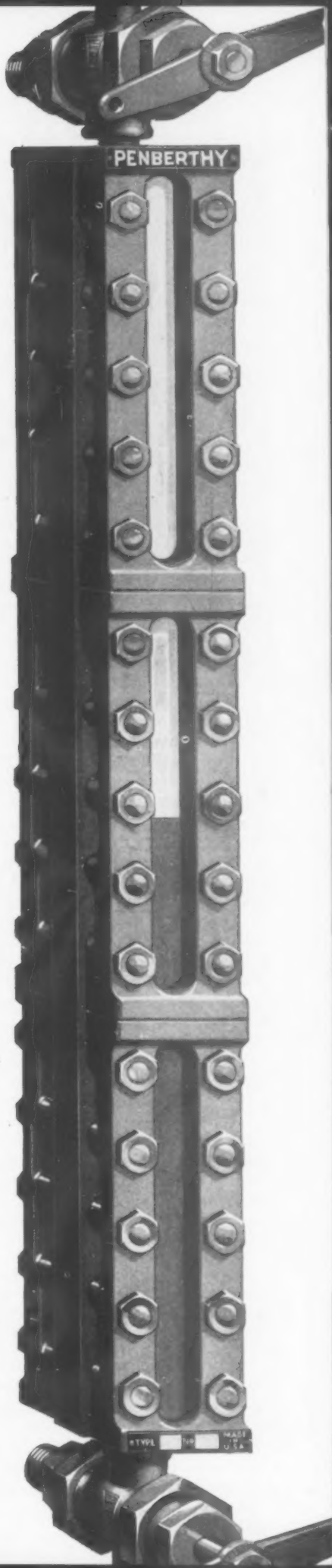

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PENBERTHY PRODUCTS

MAJOR *Pipe Line* ACTIVITIES

USE of the 24-in. and 20-in. War Emergency pipe lines after the war for moving natural gas from Texas to the New York-New Jersey-Philadelphia area is sponsored by Sidney A. Swensrud, vice president, Standard Oil Company (Ohio), in the summer number of the *Harvard Business Review*. Swensrud points out that "the disposition and future use of these lines constitutes one of the most important problems of postwar readjustment in the oil industry."

"Because of the extensive tanker construction program and our marked success in combating submarines," said Swensrud, "it appears probable that at the end of the war we may have a surplus instead of a shortage of tankers. If this surplus should develop, then there is considerable doubt that these lines would continue to be used for moving crude petroleum or petroleum products to the East Coast."

"The eastern area, located at the destination of the lines, contains the heaviest concentration of population in the United States and is not now served with natural gas. At the other end of the lines lie the greatest discovered natural gas reserves in the United States, if not in the world, and many of the fields making up this reserve have very little market outlet for their gas."

After a careful examination of the costs and revenues involved in the operation of the pipe lines by private enterprise, Swensrud concluded:

"The potential market for natural gas at the destination end of the lines is ample to utilize their combined capacity.

"On the basis of an average of 100 to 120 billion cu. ft. per year, the gas marketed through these lines would amount to only 3 to 4 per cent of the total consumption of natural gas in the United States at the present time, which is estimated to be in excess of 3 trillion cu. ft. a year, and the total deliveries through the lines in a 10-yr. period would be equal to only about 1 per cent of the estimated size of present known reserves of gas in the United States. There would appear, therefore, to be adequate supplies available for the lines.

"The costs of gas at the source plus the cost of transportation through the War Emergency lines to the destination, including return on investment at the highest levels permitted, would make it possible to deliver the gas into eastern distributing systems at an estimated amount of 23 to 26 cents per thousand cubic feet.

"On the basis of such delivered costs, there appears to be no question but that attractive rates to consumers, comparable to those in other central-eastern areas where conversion to natural gas has occurred, could be established.

"The gas delivered through the lines would displace the coal and oil now used to manufacture artificial gas, plus certain other quantities now used by consumers who would switch from other fuels to natural gas, but such loss of coal and oil volume would appear to be small in relation to the total volume of these products sold in the area."

The Sohio Pipe Line Company has been granted a charter to operate in Oklahoma. It is understood that it will lay a gathering system in the West Edmond field where the Sohio Petroleum Company has considerable production.

Pacific Lighting Corporation, Los Angeles, is making plans for construction of a 26-in. pipe line from the Hugoton gas field of Oklahoma and Kansas, to Riverside, California, where it will connect with systems of affiliated companies. Although considered a postwar project, arrangements are already being discussed for the purchase of gas and some surveying is being done. The line is expected to extend nearly 1000 miles across the country, going via Gallup, New Mexico, and Needles, California.

It is reported that Secretary Ickes' proposed Arabian pipe line has been definitely abandoned as a government project in favor of private construction. As an alternative to federal construction of the projected 1250-mile line, it was suggested the government might offer loans to private companies to help defray the cost, estimated at about $165,000,000.

There is still no definite announcement from Petroleum Reserves Corporation and hints have come from administration circles that the action was simply delayed and would be revived at a period considered more favorable for public approval.

The Utah Oil Refining Company of Salt Lake City has applied to Petroleum Administration for War for permission to construct a 100-mile 6-in. pipe line from Craig, Moffat County, northwestern Colorado, to Wamsutter station, Sweetwater County, southwestern Wyoming. At the latter place it would tie into the Stanolind Pipe Line Company main line from Salt Lake City to Casper. Work would be done by the Stanolind crews.

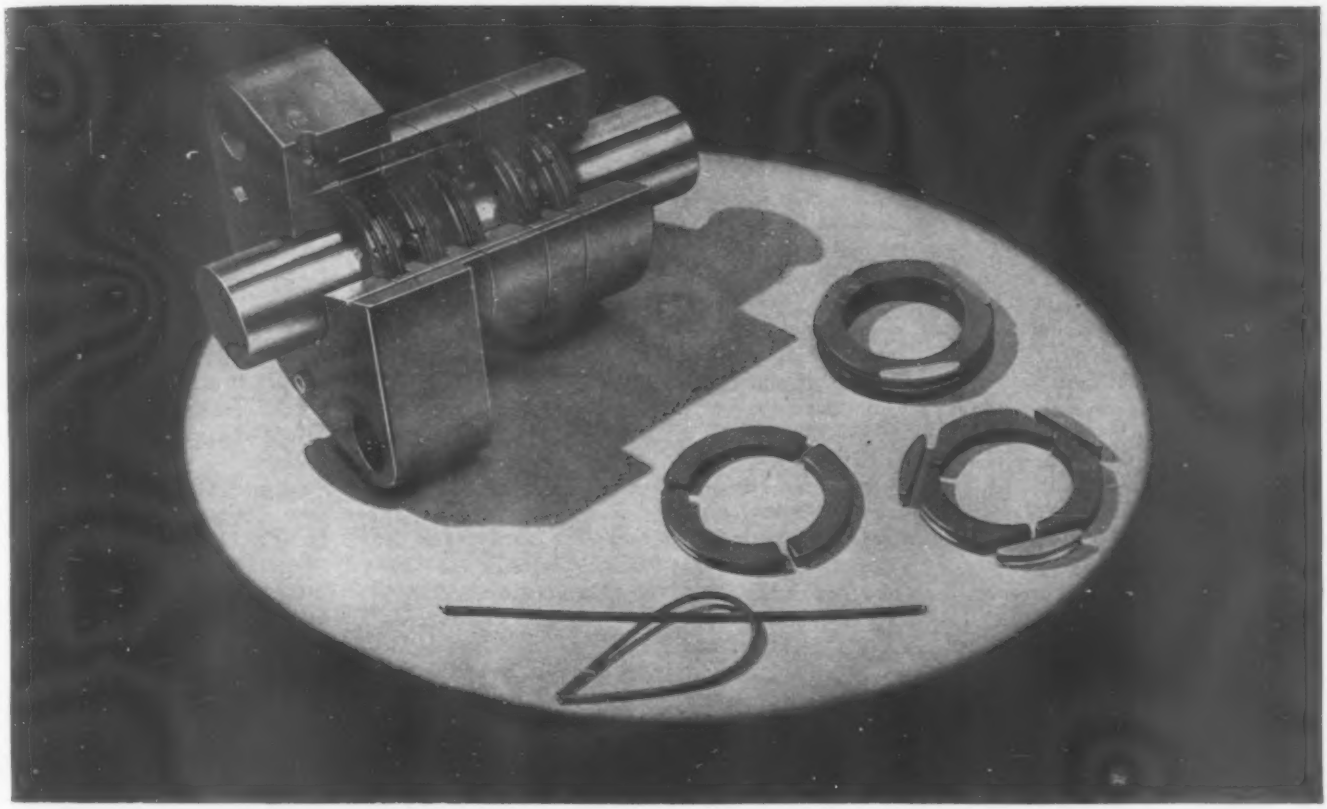
The office of Petroleum Administration for War, District 2, at Chicago, has refused to approve application of 7 oil companies for construction of additional pipe lines from the West Edmond pools of Oklahoma County, Oklahoma. It stated, after consideration of briefs submitted in the matter, that the Cimarron Valley Pipe Line presently serving the field has ample capacity to handle the production likely to result from present operations and that so long as capacity exists in this line, no new line will be approved.

The pipe line company was instructed by PAW to make whatever changes are necessary to move the oil from the field to other connections at Oklahoma City. The Cimarron Valley will retain its status as a private carrier. The fact that it has been instructed by a government agency to transport oil for all companies protects it as a private carrier from being declared a common carrier when oil is accepted.

Magnolia Pipe Line Company has boosted the capacity of its new 12-in. line from the West Texas Permian Basin to Corsicana in East Central Texas, where the carrier ties into the company's north-south trunk system. The original 42,000 bbl. daily has been increased to a reported 56,000 bbl. The line transports chiefly sulphur-bearing crude oil.

The Valvoline Oil Company, whose property included a refinery at Butler, Pennsylvania, and a pipe line system that gathered crude oil from New York state through Pennsylvania into southern West Virginia and eastern Ohio, has been acquired by Freedom Oil Company, Freedom, Pennylvania.

Earle M. Craig, president of Freedom, made the announcement. Purchase price for "the large majority interest" acquired is not disclosed although Craig said that Valvoline, established in 1882, had assets in excess of $7,500,000. The company will continue to operate under G. P. Doll, president of Valvoline, and other incumbent officers with the exception that the following Freedom officials will become officers: William G. Bechman, chairman of the board; Craig, executive committee chairman, and C. Lloyd Archer, treasurer.



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MAJOR *Oil Field* ACTIVITIES

▶ **Kansas.** A new Mississippi lime pool was opened by the Skelly Oil Company No. 1 Norton, NWC NE 23-17-26w, 3½ miles northwest of the Aldrich pool of Ness County. Production of 125 bbl. a day comes from 4450-61 ft.

▶ **Wyoming.** Continental Oil Company has announced discovery of a wildcat well that indicates a new field with the completion of its No. 1 Wright in the Little Buck Creek area, Niobrara County. On test the well produced 184 bbl. of 42.3 gravity oil in 8 hr. from the Lower Dakota sand at 3847-67 ft. The Wright well is 10 miles east of the Lance Creek field and 4 miles east of the nearest production, a single well that has been producing for many years.

▶ **Illinois.** A possible new pool opener is the No. 1 Amsbury of Rehfield and Dolly, Chicago. The well has the McClosky limestone from 3236-45 ft., which made 2000 ft. of oil on a drillstem test. The test is in Wayne County in NE NE SE 9-1n-9e.

▶ **Kentucky.** A good prospect for a new pool is the Sohio Petroleum Company No. 1 Rash Heirs, SW SW SE 24-0-25. The Tar Springs sand is from 1710-23 ft. It showed gas and oil on a drillstem test.

▶ **Oklahoma.** Sunray Oil Corporation has opened a new deeper oil sand in Pontotoc County near its refinery. The well is producing an estimated 1000 bbl. daily from approximately 4000 ft. Shallower pay has been producing for 25 years.

▶ **Texas.** A new Marble Falls field was found by Burk Royalty Company in block 495, TE&L survey. No. 1 E. C. Stovall began flowing 20 bbl. an hr. from the Marble Falls sand at 4354-67 ft.

▶ **Texas.** Both a gas-condensate and an oil pool has been opened by Sinclair Prairie Oil Company No. 1 Thompson in Colorado County. The discovery was completed for 74 bbl. of condensate and 3,160,000 cu. ft. of gas daily from sand at 8190-94 ft. It was also completed for 59 bbl. of oil and 735,000 cu. ft. of gas from sand at 9288-94 ft.

▶ **Kansas.** A new discovery is Cities Service Oil Company No. 1 Vacek, NE NE SW 32-15-10w, Ellsworth County. It produces 101 bbl. daily from Arbuckle lime at 3320 ft.

▶ **Venezuela.** Standard Oil Company of California plans to resume oil exploration in Venezuela and has set up a new subsidiary, Richmond Exploration Company of Venezuela, for the purpose.

▶ **Louisiana.** A new producing stratum has been opened by The Texas Company No. 93 Leeville in the Leeville pool of LaFourche Parish. The discovery was perforated from 11,403 to 11,428 ft. and flowed on potential 260 bbl. of pipe line oil in 24 hr. through ⅛-in. tubing choke.

▶ **Wyoming.** An Ordovician discovery has been made for the Oregon Basin field of Park County by the Ohio Oil Company. Production has formerly been in the Embar formation. The discovery is No. 5 Helene, NW SW SW 29-51-100w, which at 4362-4465 ft. found 103 ft. of sand, most of it saturated.

▶ **Texas.** Opening of a new pool in Jones County by Merry Brothers and Perini and Alder Oil No. 1 Weaver was indicated, which had a good show in the Cook sand from 2461-65 ft. Oil rose rapidly and stood 50 ft. while drillers were underreaming casing. No. 1 Weaver is in section 6, block 17, T&P survey.

▶ **Louisiana.** Humble Oil and Refining Company has definitely opened a new field in the College Point area, St. James Parish, coastal Louisiana. No. 1 Rosa Roussell Keller is flowing 8½ bbl. an hr. from perforations at 10,758-765 ft.

▶ **Oklahoma.** The Mid-Continent Petroleum Corporation opener in Cleveland County, No. 1 Westermeir, NE SW SW 26-10-3w, flowed 757 bbl. of oil in the 20 hr. after being washed into production. Flow increased to 40 bbl. an hr. It is through perforations between 8833-65 ft. in the Second Wilcox. The structure is said to be separate from that of other producers in this section.

AVERAGE CRUDE OIL PRICES

California		Louisiana	
Kettleman Hills	$1.23-1.29	Rodessa	$ .88-1.20
Playa Del Rey	.80- .87	Gulf Coast	.93-1.36
Coalinga	.73-1.13	North Louisiana	.98-1.30
Wilmington	.68-1.24		
Montana	1.00-1.15	Illinois	1.22-1.37
Wyoming	.45-1.15	Kentucky	1.32-1.43
Colorado	1.05-1.07		
New Mexico	.70-1.15	Indiana	.85-1.25
Texas		Ohio	
North Central	.97-1.25	Lima	1.50-1.60
Panhandle	.70-1.12		
West Texas	.80-1.27	Michigan	1.24-1.44
Gulf Coast	.93-1.48		
Darst Creek	1.14	Pennsylvania	
East Texas	.80-1.27	Bradford	3.00
Talco	.79	Southwest	2.65
Kansas	.93-1.25	Eureka	2.59
Oklahoma	.75-1.25	Buckeye	2.30
Arkansas	.94-1.36	Corning	1.31

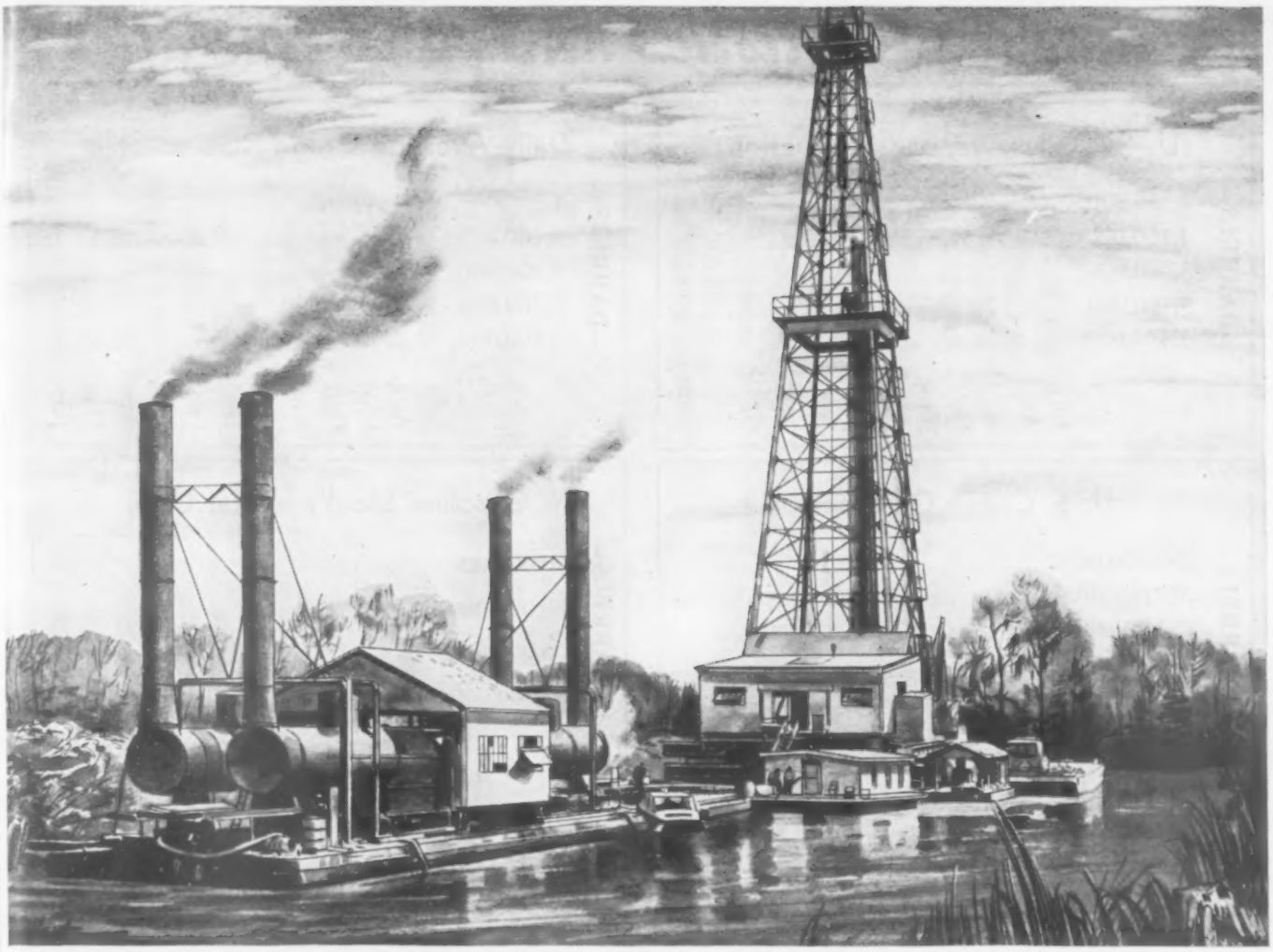
DAILY AVERAGE CRUDE OIL PRODUCTION

Data Supplied by A.P.I.

(Figures in bbl. of 42 gal. each)

		ACTUAL PRODUCTION		
	*P.A.W. Recommendations June	Week Ended June 24, 1944	Week Ended Apr. 22, 1944	Week Ended June 26, 1943
Oklahoma	332,000	332,300	335,550	339,450
Kansas	274,000	289,700	263,800	306,950
Nebraska	1,000	1,000	1,200	2,200
Panhandle Texas		92,150	91,100	90,100
North Texas		149,400	143,850	131,800
West Texas		447,900	374,000	228,950
East Central Texas		145,000	127,250	123,500
East Texas		360,550	362,300	334,900
Southwest Texas		312,950	293,050	208,250
Coastal Texas		528,450	518,800	380,200
TOTAL TEXAS	2,039,000	2,036,400	1,910,350	1,497,700
North Louisiana		74,200	76,150	84,700
Coastal Louisiana		288,750	282,500	240,850
TOTAL LA.	350,000	362,950	358,650	325,550
Arkansas	78,000	80,250	79,550	75,150
Mississippi	42,000	45,350	42,850	53,100
Alabama		100	100	
Florida		50	50	
Illinois	220,000	209,550	201,700	207,750
Indiana	14,000	12,900	13,850	14,500
Eastern	73,600	66,800	72,500	76,950
Kentucky	23,000	21,750	24,350	19,800
Michigan	51,000	47,200	48,500	54,400
Wyoming	94,000	91,450	98,700	92,000
Montana	24,400	21,300	21,500	20,850
Colorado	7,400	8,350	8,200	6,900
New Mexico	113,000	108,000	112,050	97,150
TOTAL EAST OF CALIF.	3,736,400	3,735,400	3,593,450	3,190,400
California	849,200	847,800	833,900	764,500
TOTAL U. S.	4,585,600	4,583,200	4,427,350	3,954,900

*P.A.W. recommendations and state allowables, as shown above, represent the production of crude oil only, and do not include amounts of condensate and natural gas derivatives to be produced.



JELFLAKE—INSURANCE AGAINST LOST CIRCULATION

Most lost circulation problems are effectively solved with Jelflake. This organic material has been used successfully to seal many types of formations.

When cement slurry or drilling mud, in which Jelflake has been mixed, enters a thief formation, an impervious wall builds up on the face of the formation, permitting neither mud nor slurry to pass through it. Exceptions being cavernous or large fissured formations.

Lost circulation cannot be anticipated and usually occurs at most inopportune times. Many operators keep Jelflake on hand to meet such emergencies. In all drilling operations, Jelflake is considered low-cost insurance against expensive mud and cement losses.

Jelflake can be secured in all major drilling areas through Dowell stations or distributors. Write Tulsa office for samples and further information.

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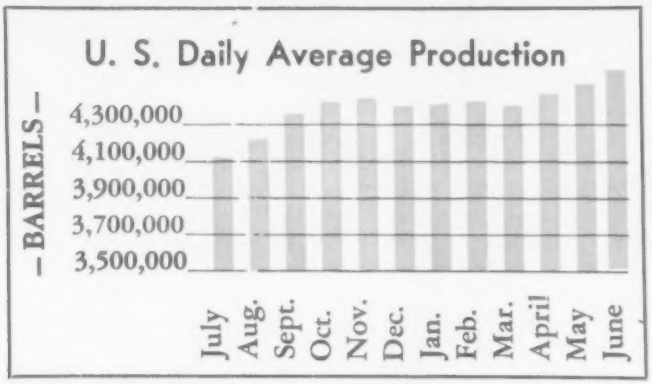
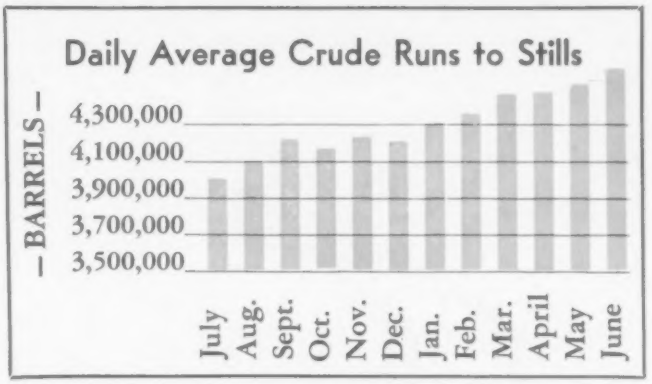
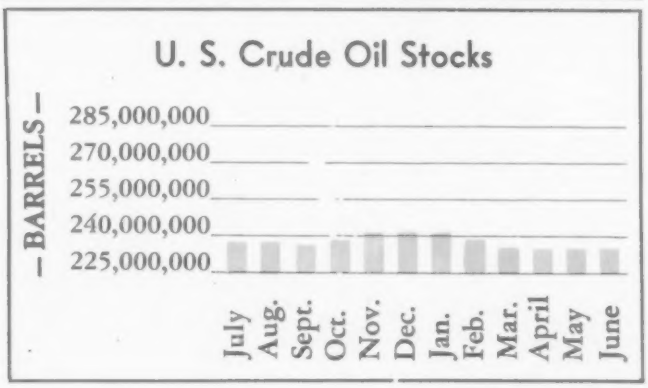
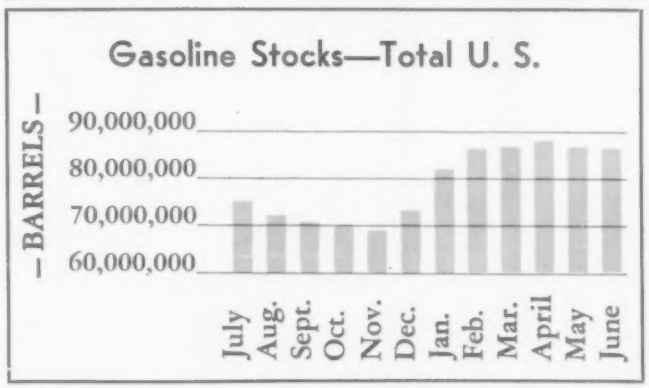
PETROLEUM *Statistics* AND FIELD *Operations*









Above statistics by American Petroleum Institute.

Summarized Operations in Active Fields for June, 1944

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
TEXAS								
Eastern Texas	27	11	19	26	3500-4700	2	40	Rotary
Gaines County	36	21	3	....	4400-5584	2	22-35	Rotary
Hockley County	16	14	9	....	4800-6850	2	20-30	Rotary
Ector County	21	9	11	....	3675-4377	2 or 3	32-36	Rotary
Panhandle	18	14	7	....	1700-3900	2	40	Rot.-Cab.
Nueces County	13	11	11	....	3922-5878	2 or 3	21-54	Rotary
K. M. A. Field	17	3	5	....	3730-3935	2	42-43	Rot.-Cab.
Hawkins Field	9	4	7	13	4495-4912	2	19-29	Rotary
OKLAHOMA								
Okfuskee County	12	7	7	....	2150-4125	2 or 3	38	Rotary
KANSAS								
Russell County	15	5	5	....	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	6	3	4	....	3222-4085	2 and 5	42-48	Rot.-Cab.
Barton County	10	6	5	....	3290-3518	2	39-24	Rot.-Cab.
ILLINOIS								
Central Illinois	90	21	101	110	1425-4100	2	36-38	Rot.-Cab.
NEW MEXICO								
Lea County	6	2	3	....	3150-4030	2	30-34	Rot.-Cab
CALIFORNIA								
Kern County	25	7	10	14	1840-11,450	2 or 4	14-20	Rotary
Wilmington County	11	6	10	13	3500-4000	2 and 3	18-20	Rotary

Field Activities by States for June, 1944

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1943 (bbl.)
	June	May	June	May	June	May	June	May	June	May	
Arkansas	18	14	10	9	16	11	7	9	13	18	27,605,000
California	77	67	55	31	50	59	30	29	21	16	284,415,000
Illinois	68	43	66	50	71	79	85	88	123	122	81,070,000
Indiana	20	8	18	10	16	33	6	10	14	16	5,320,000
Kansas	121	82	83	60	40	52	23	30	14	25	105,780,000
Kentucky	28	23	27	28	15	21	....	....	....	10	7,890,000
Louisiana	46	40	36	26	24	21	15	16	16	....	125,904,000
Michigan	47	24	26	18	21	20	11	....	23	20	20,576,000
Mississippi	6	6	4	2	....	....	....	10	....	16	18,845,000
Montana	12	4	5	8	....	....	5	9	....	....	7,598,000
Nebraska	....	1	....	2	3	....	....	....	....	4	791,000
New Mexico	23	15	13	11	11	9	....	....	....	12	38,955,000
New York	86*	70*	78*	85*	39	58	24	15	....	....	4,783,000
Ohio	55	29	45	28	30	28	19	14	....	50	3,220,000
Oklahoma	118	55	68	44	44	41	....	....	46	43	120,880,000
Pennsylvania	187*	188*	183	80	129	161	....	....	....	....	15,988,000
Texas	208	202	230	201	284	311	222	210	270	301	588,560,000
West Virginia	54	76	43	51	22	12	3	3	15	14	3,256,000
Wyoming	6	4	3	4	2	1	3	6	9	5	34,686,000
Total	1160	951	992	748	806	925	453	449	564	624	1,496,120,000

*Includes water-intake and pressure wells.

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- Well loads are easily and effectively counterbalanced with adjustable beam counterweights.
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- Rigid, four-leg, derrick-type samson post provides utmost strength and stability and equalizes stresses.
- Wide-spaced saddle bearings resist weaving and twisting, keep the walking beam in alignment, and avoid destructive side thrusts.
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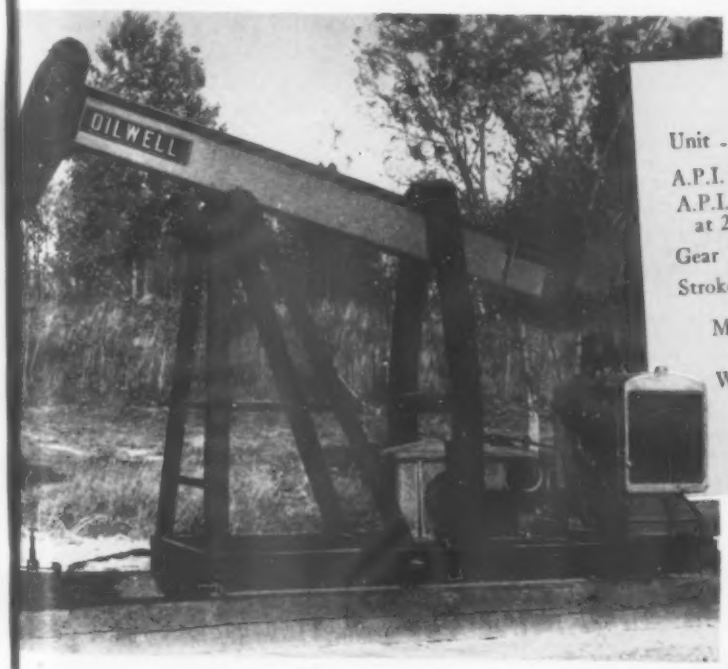

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SPECIFICATIONS

	TC-5A	TC-8A
Unit		
A.P.I. Polished-Rod Load Capacity, pounds	5,100	9,500
A.P.I. Peak-Torque Capacity at 20 s.p.m. ---inch-pounds	22,800	38,600
Gear Ratio	32 : 1	42.15 : 1
Stroke Lengths ---inches	16, 18, 20½ and 24	22½, 25, 28¾, 30 and 34
Maximum Counterbalance Effect with Cast-Iron Counterweights---pounds	3,930	6,900
Weight with Standard Equipment:		
Domestic ---pounds	1,788	3,307
Export ---pounds	2,623	4,670

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MAJOR *Refining* ACTIVITIES

DETAILS of the manufacture of neoprene synthetic rubber have been made available to the Soviet Union without charge "while Russia is at war with Germany," it was announced by E. I. Dupont de Nemours and Company. Taken at the request of the United States government, the step is the first large scale agreement of its kind to be announced.

Under the agreement, dated June 22, 1944, full details for the production of neoprene, the first successful general purpose synthetic rubber ever developed, were turned over to the Soviet. The company said its policy is to grant the U. S. government "free rights under its patents and processes for military purposes during the period of the war" and no compensation will be asked of the Soviet Union "for the production of neoprene while Russia is at war with Germany." The volume of Russian production of neoprene in the postwar period will determine the amount of compensation at that time, the company said.

J. E. Crosbie, Inc., of Tulsa, Oklahoma, is just completing two units of its new gasoline plant in the southeast Stroud pool of Creek County, Oklahoma. These will give the plant a capacity of 2,000,000 cu. ft. of gas a day. Gas for the plant is obtained from several nearby pools.

Eighty per cent of the projects in the 100-octane aviation gasoline program has been completed, the Petroleum Administration for War announced. Of the 189 projects undertaken, 150 have gone into operation. Seven were built in 1942; last year 71 were built, and so far this year 72 have been completed. Of the others, 25 will be ready this summer and the remainder this fall.

PAW's report did not include units that were contributing to 100-octane production before the start of the present program. In all about 450 refineries and natural gasoline plants now are making 100-octane or components of the aviation fuel.

At least 20 of 22 oil refineries attacked by Italy-based Allied bombers had been put out of service by mid-June, it was reported by the Associated Press. Production at Ploesti, which had been the source of 35 per cent of German supplies, was said to have been cut to very low levels.

"More than half the German synthetic oil production has been knocked out by attacks of the Eighth Air Force based in the United Kingdom," it was announced. "So much damage has been done to oil plants, ranging almost from the Baltic to the Black Sea, that the enemy's stored reserves represent his main cushion against having his military machine brought to a grinding halt."

Crude Runs to Stills, Production[1] and Stocks[2] of Motor Fuels

Week ended June 24, 1944

A.P.I. Figures

(Figures in thousands of bbl. 42. gal. each)

DISTRICT	DAILY REFINING CAPACITY Potential Rate	DAILY REFINING CAPACITY Per cent reporting	CRUDE RUNS TO STILLS Daily average	CRUDE RUNS TO STILLS Per cent operated	Total production[3]	Total stocks[3]
*Combined: East Coast, Texas Gulf, Louisiana Gulf, North Louisiana-Arkansas, and Inland Texas	2,518	90.3	2,373	94.2	12,738	78,118
Appalachian						
District No. 1	130	83.9	101	77.7	551	3,398
District No. 2	47	87.2	55	117.0	318	1,741
Ind., Ill., Ky.	824	85.2	768	93.2	4,679	29,300
Okla., Kans., Mo.	418	80.2	376	90.0	2,325	10,997
Rocky Mt.						
District No. 3	13	17.0	12	92.3	73	111
District No. 4	141	58.3	110	78.0	669	3,482
California	817	89.9	843	103.2	5,013	55,132
TOTAL U.S. June 24, 1944	4,908	87.2	4,638	94.5	28,066	182,280
TOTAL U.S. June 17, 1944	4,908	87.2	4,752	96.8	30,246	180,446
U. S.— June 26, 1943			4,007		24,607	186,369

*At the request of the Petroleum Administration for War.

[1]Production—total of gasoline at refineries including natural and blended; kerosine, gas, and distillate fuel oil, and residual fuel oil.

[2]Stocks at refineries, bulk terminals, in transit, and pipe lines of finished and unfinished gasoline; kerosene, gas oil, and distillate fuel, and residual fuel oil.

[3]Figures on production and stock include reported totals plus an estimate of unreported amounts and are on a Bureau of Mines basis.

The Globe Oil and Refining Company has sold its refinery properties at Blackwell, Oklahoma, to W. D. Scallon, Lee Walker, and Ray Humphries of Tonkawa. The purchase includes 50 acres of land, buildings, and equipment. The refinery had a rated capacity of 8000 bbl. daily at the time it was shut down about five years ago. Globe will retain and continue operation of its pipe line that gathers oil northeast of Blackwell and delivers it to connections in the Hubbard field southwest.

Sinclair Oil Corporation has announced that it plans to build a 35,000-bbl. refinery in Venezuela for the production of 80-octane gasoline and navy diesel oil fuel. Plans for construction of the refinery, which will be built on a site already owned by Sinclair near the Puerta de la Cruz terminal of the Venezuelan Oil Corporation, will include crude and cracking stills, acid plants, an electric generating station, housing for employees, a hospital, and school.

Building of the refinery, the company states, will depend on available material and shipping. The announcement was made by Sinclair following inquiries on the formation of two Venezuelan subsidiaries—Sinclair Oil Company of Venezuela and Sinclair Refining Company of Venezuela.

Management of Petroleos Mexicanos, Mexico City, has announced that oil refineries at Cuidad Madero, Tamaulipas, will work three shifts a day instead of one to meet industrial, agricultural, and private oil needs while more tank cars for the government-controlled company are available.

Between 60,000 and 80,000 gal. of gasoline are being loaded in trucks of private companies and shifted to the states of Jalisco, Michoacan, and the northern part of the county. This system of transportation has helped solve the oil shortages but has caused an increase in transportation cost.

Heeding an urgent plea from military leaders for more high octane gasoline, Rubber Director Bradley Dewey has ordered diversion of 400,000 bbl. of butylenes from the synthetic rubber program to the production of an extra 1,000,000 bbl. of aviation fuel. The butylenes will be channeled to high octane gasoline during July and August.

A. M. Frame of Lake Charles, Louisiana, has been appointed director of the refining division of PAW, it was announced by Ralph K. Davies, deputy petroleum administrator. He succeeds Ernest D. Cumming, who has returned to his duties as vice president of Shell Oil Company, Inc.

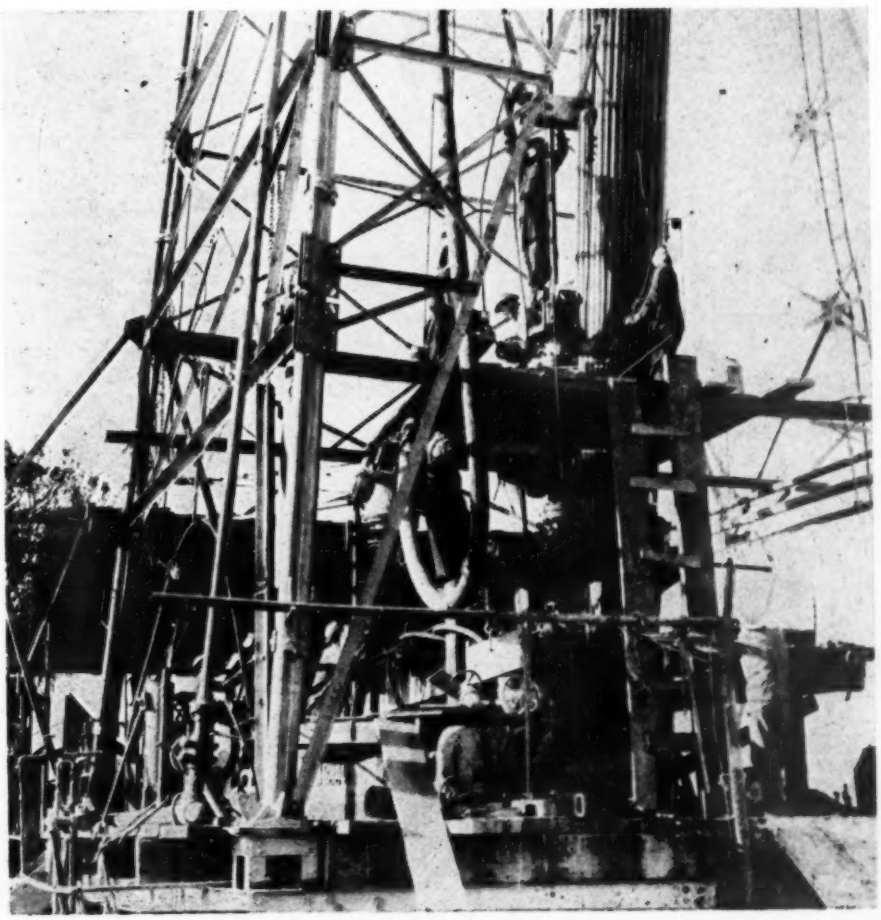
THE Petroleum Engineer
JULY, 1944

Casing Bridge in Gas Well Removed Under Pressure

☆ **Perforating gun and 8000 ft. of 4-line cable fished out with center spear on tubing string**

by C. C. Pryor, Associate Editor

IT has often been reiterated that the simplest and safest way to control a gas well threatening to blowout is to kill it with drilling mud. In many cases, however, this procedure cannot be readily accomplished due to unforeseen difficulties. Recently a well in the Chapel Hill field was drilled to approximately 8200 ft. and cased with 5½-in. pipe through the Pettit lime. When the casing was perforated with about 80 shots the well unloaded a 10-lb. mud column before the gun could be pulled from the hole. Bottom-hole pressure of the well was estimated at 3600 lb. The well was equipped with a conventional blowout preventer and a stuffingbox for the perforator line. A thread leak in the stuffingbox resulted in the box and line becoming so badly cut that 8000 ft. of line and the perforating gun dropped into the hole and the well completely unloaded. The operator immediately closed the blowout preventer and shut in the well. An attempt was made to kill the well by pumping in 14-lb. mud; however, the well would take only about 55 bbl. of fluid indicat-



Snubbing the tubing from the well. The stationary snubbers have been set on the pipe and the traveling snubber line slacked off to allow the operator to release them for another bite

ing that the line had pumped down the hole and bridged the casing approximately 2700 ft. below the surface. The bridge formed by the line and the drilling mud were sufficient to hold the well until a service company[1] specializing in such operations could rig up to recover the line and gun and bring the well under control.

Two Prong Grab

After completing installation of a control head assembly and snubbing equipment the operators then prepared to go into the well with a two-prong grab, equipped with rings welded on to prevent the possibility of the line blowing past the tool, on a tubing string to remove the line bridging the hole. The grab was made up with a 2-ft. perforated nipple and a tubing closing tool to close the end of the tubing and prevent the well blowing through the string. This closing tool was installed with the small bore of the closing tool nipple forming the shoulder against which the closing tool plunger seated. Well pressure acting against the plunger thus could not displace it upwardly from the nipple and the bore of the tubing was closed off. Although there was no pressure from the well due to the bridge and 14-lb. mud column the tubing was run into the well through the snubbing assembly as a safety precaution should the bridge give way and the well begin to unload the tubing.

Efforts to remove the bridge with the two-prong grab were unsuccessful and the tubing was removed from the well to permit running a center spear. The center spear was made up in the blank section of tubing in place of the two-prong grab and the tubing run back into the well through the snubbing and control assemblies.

Center Spear

Running the center spear on the tubing on the second trip the perforating gun line was picked up and the trip out of the hole was begun. As the spear had picked up the line near the broken end the bridge broke loose after 1000 ft. of tubing had been pulled from the hole. The pressure of the gas began to push the tubing from the hole, but the stationary snubbers were used to stop it. The remainder of the tubing in the hole was then removed by snubbing it out through the control assembly in about 10-ft. lengths. To prevent the well blowing during this operation, the upper control head was closed around the pipe. After the spear and perforated nipple on the first joint of tubing had been brought up into the control assembly with the end of the line, the well was flowed on a ¼-in. choke. The well gradually flowed down until the operators were able to flow it through a 3-in. vent line. It was necessary to flow the well down because the perforator line could not be packed off and pulled under pressure. A swage was installed from the 7-in. flange on the upper control head to 1½ in. to restrict flow through the control assembly when the upper control head was opened to remove the fishing spear and the end of the perforator line. The 8000 ft. of line and the perforating gun were then pulled from the well. The perforator line consisted of four small rubber covered lines taped together to make one line. When the line and gun were pulled from the well it was found that the line was completely undamaged.

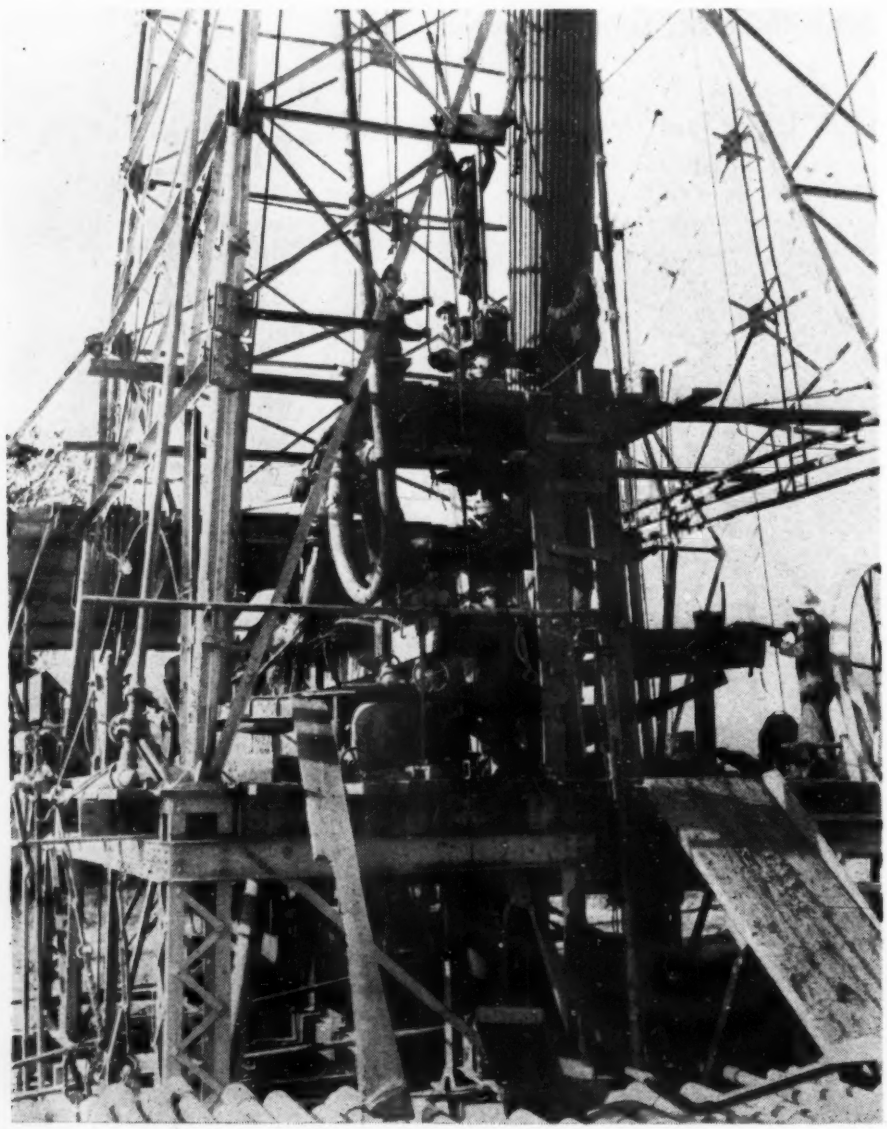
Circulating

It was not possible to kill the well by pumping mud into the casing and the tubing had to be snubbed back into the well with the center spear removed and only the tubing closing tool and the perforated nipple on the end of the first joint of tubing. When the full string of tubing had been run into the well, the tubing closing tool was opened by overloading the tubing slightly with fluid and unseating the closing tool plunger from its nipple at the lower end of the tubing string. When the plunger had been forced out, the bore of the tubing was free. Circulation was then established through the perforated section and the well killed. Wellhead connections were made and the well cleaned for final completion.

Snubbing Operations

Running and pulling pipe in gas wells under pressure is a hazardous operation unless the required special control and snubbing equipment are employed with trained personnel and a highly developed technique. Special equipment includes a control head assembly and snubbing equipment. Although the

[1]Otis Pressure Control, Inc.



Moving a coupling up through the control assembly requires closing the auxiliary control head below the coupling and opening the upper control head to remove the coupling, after which the upper head is closed and the auxiliary again opened

actual operation of the equipment is not especially difficult, safe operation by trained personnel is extremely important.

The control head assembly consists of an upper control head, a lower or auxiliary control head, and a safety control head. This assembly is in addition to the blowout preventer and master gate valve installed on the well. Snubbing equipment made up above the control head assembly consists of a set of traveling snubbers that force the tubing into the well against the well closed in pressure or remove it safely from the well under pressure, and a set of stationary snubbers employed to keep the pipe from being blown from the well during the time the traveling snubbers are raised for a new bite on the pipe. As the traveling block is raised the traveling snubbers are pulled down forcing the tubing into the well. The snubbing line passes over the center sheave of the traveling block and under the sheaves on the snub block clamp, thus an even pull on each side of the traveling snubbers is achieved eliminatnig any tendency to bend the pipe. Balancing weights automatically raise the traveling snubbers for a new bite on the pipe. The stationary snubbers are bolted to the snub block, which is flanged to the upper control head. Construction of these snubbers is such that the grip on the pipe increases as the force trying to blow the pipe from the hole increases.

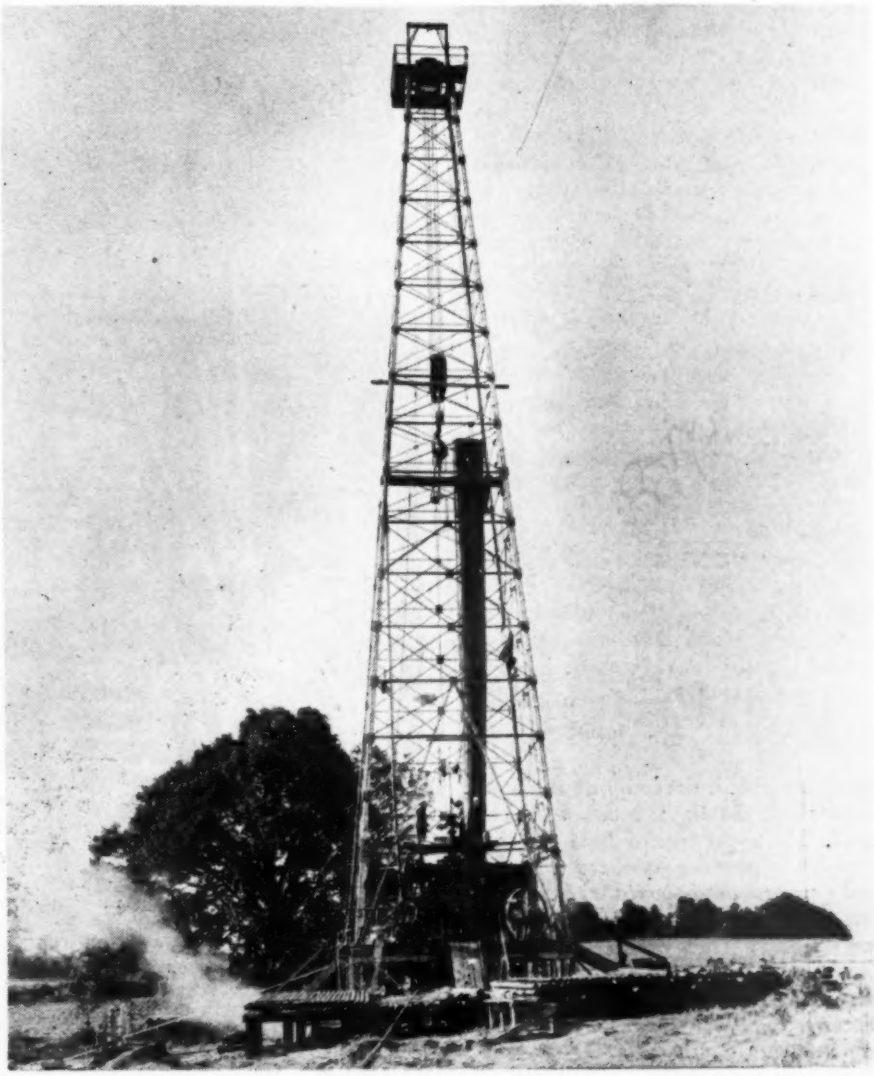
Snubbing Out

When the gun perforator line forming the bridge was removed, the operators still had about 1750 ft. of tubing in the hole. Removing the bridge allowed the pressure of the well to begin forcing the tubing out through the control assembly. The stationary snubbers were then used to catch the tubing and hold it in the well. Had the snubbing equipment not been used the entire string of tubing would have been blown through the derrick. Gas pressure forcing the tubing from the well did not start gradually, but almost instantaneously.

With the stationary snubbers holding the tubing and the upper control head closed to prevent the well blowing through the control assembly into the derrick, the traveling snubbers were lowered down to the stationary snubbers and set on the tubing. The line to the traveling block was then pulled up until the load was taken off the stationary snubbers. Then with the stationary snubbers released, the traveling block was slowly lowered and the pressure of the gas forced the tubing from the well. When about 10 ft. of the joint of tubing had been eased out of the control assembly, the stationary snubbers were set to hold the tubing and the traveling snubbers lowered for another bite on the pipe. This operation was repeated until a coupling and upset were just below the rams of the upper control head in the 2-ft. nipple between the upper control head and the auxiliary control head. The rams of the auxiliary control head were then closed around the tubing below the coupling and upset and the pressure in the nipple between the control heads equalized. Then the rams of the upper control head were opened and the coupling and upset brought out of the well under control of the traveling snubbers. After the coupling and upset passed the upper control head, the head was again closed around the pipe, the pressure equalized, and the auxiliary control head again opened. These operations were repeated for each joint of tubing until the first joint of tubing run into the well was brought up to the control assembly. Then the well was bled down, the swage installed, and the fish removed.

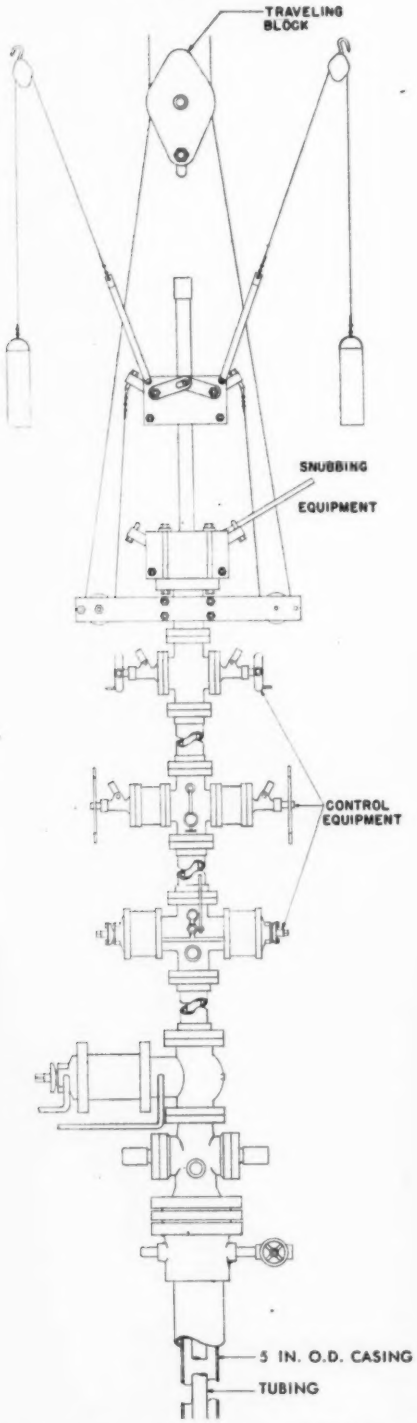
Snubbing In

Running tubing into the hole requires a reversal of the operations employed to snub tubing from the well. The master gate valve of the well was closed and the upper control head opened after the pressure was equalized. The blank joint of tubing was then run into the control assembly through the snubbers until the end was just above the gate valve; then the upper control head was closed on the tubing, the pressure equalized, and the master gate valve opened. The traveling snubbers were raised for a bite on the pipe and the tubing forced into the well by raising the traveling block and pulling the snubbers down to the stationary snubbers. This operation was repeated until the first coupling and upset were just above the stationary snubbers. Then another joint of tubing was made up. With the traveling snubbers then set for a new bite on the tubing, the auxiliary control head rams were closed on the pipe, the pressure bled off between the heads, and the upper control head



View of the rig from the pipe rack side. The traveling block is being raised to pul. the traveling snubbers down, forcing a portion of a joint into the well through the control assembly

Sketch showing the control assembly and snubbing equipment on the well. The traveling snubber line is run over the center sheave of the traveling block for an even pull on both sides of the snubbers



opened to permit the coupling and upset to pass into the nipple between the two heads. The upper control head was then closed, the pressure equalized, the auxiliary control head opened, and the tubing forced into the well by the traveling snubbers. These operations were repeated on each joint of tubing run into the well. Usually about three 10-ft. bites per joint were made by the traveling snubbers.

Repacking Rams

During the running of tubing into the well, it became necessary to replace the worn packing in the rams of the upper control head to prevent leakage even though the rams were tightly closed. The rams of the auxiliary control head were closed, the pressure released in the upper control head nipple, and the rams removed and repacked. When the rams were replaced they were closed tight against the tubing and jammed with the locking screws to set the packing. The auxiliary control head was then opened and operations resumed.

Although the auxiliary control head rams do not often become worn during a tubing job, the rams can be easily replaced by closing the safety control head, bleeding the pressure off above the head, and then removing and repacking the rams. After repacking and replacing the heads, the pressure is equalized, the safety control head opened, and operations resumed using the upper control head.

When long strings of tubing are being run into wells under high pressures with the snubbers, the length of the bite taken by the traveling snubbers can be increased after the weight of tubing lowered into the hole becomes large enough to overcome the pressure of the well acting on the area of the pipe. The pipe will move into the well more and more easily when this point has been reached. As an additional safety measure to prevent the string of tubing from slipping through the control assembly, the derrick line or catline may be used. This line is tied to the upper end of the joint being run through the snubbers and if the pipe tends to drop into the well of its own weight when the line is slacked off, the stationary snubbers are closed to hold the pipe.

Acknowledgment

The writer is indebted to Otis Pressure Control, Inc. for the material contained in this article.

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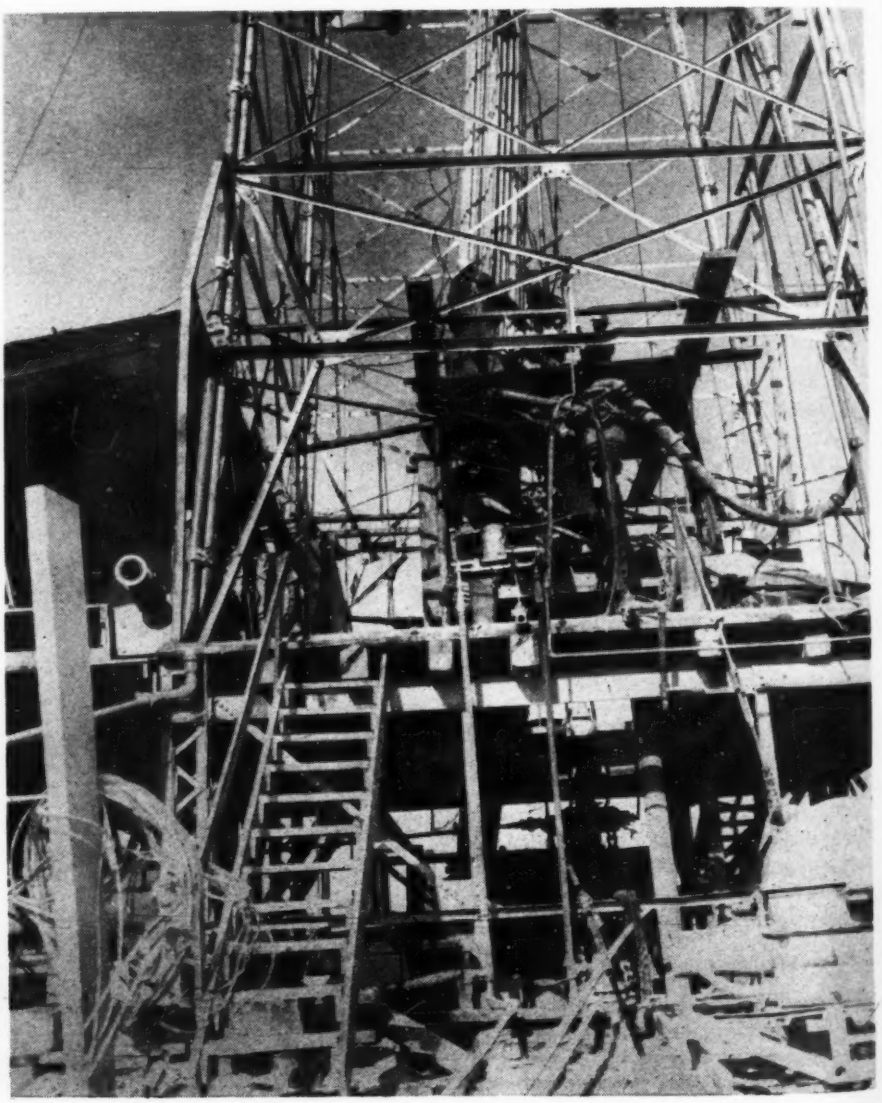
Platforms permit easy access to the snubber and control assemblies. The driller and cathead man work on signals from the snubber platform



Determining Wall Thickness Of Tubing in Wells

PETROLEUM ENGINEER Exclusive Feature

☆ **Valuation of tubing and drill pipe in service increases period of usefulness**

by Wallace A. Sawdon
Pacific Coast and Foreign Editor

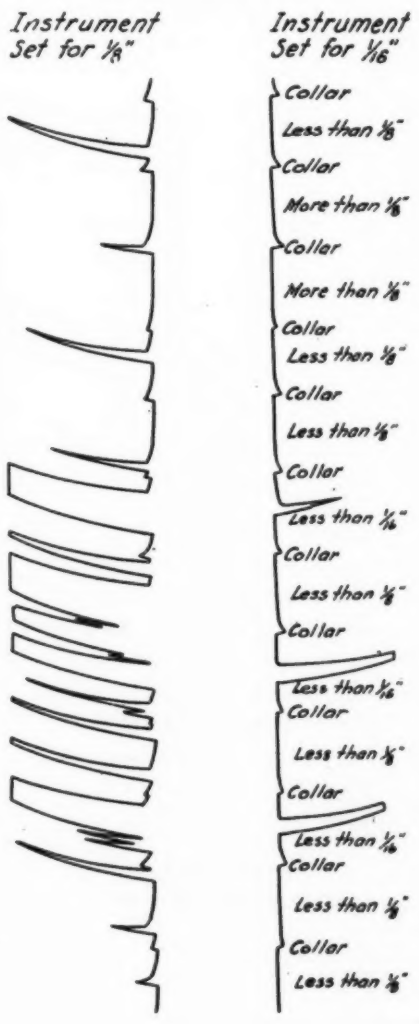
THE oil industry is acutely aware of the particular necessity at this time for employing steel to the utmost of usability commensurate with safety and efficiency of operation. Tubing and drill pipe, however, are subject to wear that is frequently excessive and tubing particularly is subject to corrosion of various types and to electrolytic action. Fatigue demands greater consideration in drill pipe than it does in tubing but the reduction of wall thickness is of greater concern in tubing.

The valuation of tubing and drill pipe strings in service and the classification of joints (lengths) for further use or discard requires more than inspection with the naked eye. Wear and corrosion of tubing is generally on the inside face of the pipe and fatigue is a condition of the metal structure. Detection of the result of destructive effects (except those of external wear and corrosion) thus requires the use of instruments. Several such instruments, and services for their use, have been developed and will be discussed individually in a series of articles of which this is the first. The present discussion is confined to classification of tubing according to remaining wall thickness.

This classification is determined by Dia-Loy tubular surveys, which are usually run while the tubing is in the well but which can be made when the pipe is on the rack. The surveys can also be made on casing to be salvaged, as mentioned in a previous article.[1] In making the survey in the well the instrument is run on a 5/16-in. steel wrapped cable through which current is conducted from batteries at the surface. The cable is raised and lowered in the well with a winch that is driven through a power take-off by the engine of the truck in which the equipment is mounted. A measuring device measures the cable in and out of the hole and also drives an automatic recorder in synchronization with the cable so that the vertical scale on the record chart remains constant at 50 ft. of depth per inch regardless of the speed at which the survey is made. Surveys are made from the bottom up to assure greater accuracy.

The recorder traces on the chart as it moves in synchronization with the cable a straight vertical line until the pen is moved to right or left by an electrical impulse from the instrument in the well. (See Fig. 1). When two runs are made the movement of the pen during the first run is toward the left; when the second run is made a switch on the recorder is thrown to cause the pen to move to the right when recording impulses. If three runs are made, two are usually to the left and one to the right, the direction of movement of the pen merely being to avoid confusion in reading the chart.

Fig. 1. Chart made by the recording instrument



The chart shows the location of each coupling as well as any spot in the tubing where the wall thickness is reduced below the limit for which the instrument is set. Tubing catchers are also located. The collar location checks tubing measurements and clearly identifies the joints (lengths) for classification.

The instrument itself is essentially an assemblage of contact fingers that are held in continuous contact with the inside of the pipe by springs that force them outward into any depressions in the face of the pipe. The outward movement of any finger beyond a limit for which it is set makes an electrical contact and it is this contact that causes the horizontal pen movement across the chart in the recorder. The contact fingers are spaced at ⅜-in. intervals around the circumference of the instrument and thus will detect a worn spot as small as ⅜ in. in width. The instrument is centered in the tubing by spring-type centralizers placed at each end.

The measurements are based on the outside diameter of the tubing and before the instrument is run into the well the fingers are set to indicate when the remaining wall thickness is less than a preestablished amount. For example, if the fingers are set to record a remaining wall thickness of ⅛ in., the electrical contact will not be made until one or more fingers extend outwardly to or beyond a point within ⅛ in. from the outside diameter of the pipe. Every time a finger moves outwardly to or beyond the cylindrical plane lying at a distance of ⅛ in. within the outside diameter of the pipe, contact will be made and the point recorded on the chart.

[1] "Casing Salvage Aids Steel Conservation," by Wallace A. Sawdon, *The Petroleum Engineer*, September, 1943.

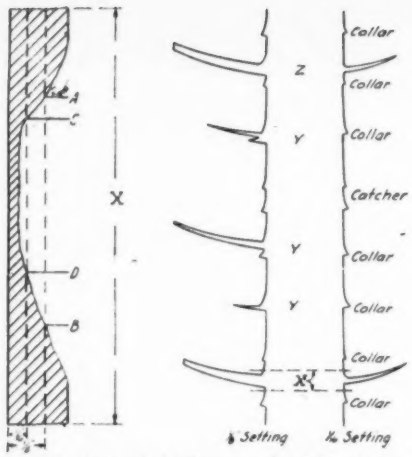


Fig. 2. Actual thickness of tubing is not measured; rather the points are indicated at which wall thickness is less than that for which the tool is set

The settings generally used for surveying tubing are ⅛ in., 3/32 in., and 1/16 in. In most cases, however, only two runs are made, one with a setting of ⅛ in. and a second of 1/16 in. Any desired setting can, of course, be used.

The actual wall thickness of the pipe is not measured by the Dia-Loy survey. As illustrated by Fig. 2, what is indicated are the points at which the thickness is less than that for which the tool is set. In Fig. 2, a bad spot is located at "X." In making the run recorded on the left, where the instrument was set for ⅛ in., the finger made a contact for the distance from "A" to "B" shown on the enlarged section. This indicated that the thickness of the wall between "A" and "B" was less than ⅛ in. It did not, however, indicate how much less. It was not until the run on the right was made with the instrument set for 1/16 in. that it was found that the thickness of the wall between "C" and "D" was less than 1/16 in. This also did not show how much less than 1/16 in. the wall thickness was, but since it was less than 1/16 in. it was too thin for use as tubing in an oil well. Farther above on the survey record there are points at "Y" that are indicated by the curve to the left as having wall thickness of less than ⅛ in., but when the curve to the right was run it was found that the wall at point "Y" was not as thin as 1/16 in. and so the thickness was known to be between ⅛ and 1/16 in. At "Z," however, the pipe was found to be less than 1/16 in. thick, a condition similar to that at "X."

Tubing is usually surveyed for bad joints (lengths) before being pulled, generally after a split joint or some other trouble has occurred. The joints being thus classified, they are segregated as pulled from the well, the fair joints being assigned to lighter duty and the poor joints replaced. The advantages of knowing the condition of the tubing string are obvious and no discussion is necessary of economics involving lost production, shut-down time, pulling expense, etc., from repeated failures requiring successive lay-downs of the entire string.

Another use for the survey of tubing is when a used string is to be employed in pressure cementing operations. By removing any thin joints (lengths) the danger of bursting under the high pressures necessary for putting away the cement is eliminated. A split joint during such operations frequently results in cementing the tubing in the well.

Tubing used for cementing is generally on the rack, but much used tubing is frequently on the rack awaiting assignment for production service, and by inspection it may be graded according to remaining wall thickness. When so graded it may be segregated for service in deep wells or shallow wells, for low pressure pipe lines, or for junk.

When surveying tubing on the rack the worn or corroded areas are indicated by an electrical buzzer. The location and extent of the thin wall areas are determined by measuring the distance the instrument has been moved from the end of the pipe. The operation of the instrument itself is the same as when it is run through tubing in the well but because no recorded curves are provided the condition of the joints must be marked as the inspection is made.

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Drilling Materials Under War Conditions

If the present upswing in drilling activity is continued, the industry must receive (1) improved quality of materials, (2) adequate stocks of repair parts, (3) improved service facilities, and (4) relief from shortage of skilled manpower.

Constantly increasing depths to which wells are being drilled are taxing the strength of many rig parts to the limit. If this continues, the best possible alloys with the highest strength and best wearing qualities are necessary to minimize drilling time.

An adequate supply of repair parts, including bits, tool joints, bearings, engine parts, etc., will get more hole drilled per pound of material expended than any other single item. Skilled labor and more repair materials must be made available to field repair shops in order to insure better work, longer runs between repair jobs and more footage drilled.

Additional trucks, tractors, and earth-moving equipment with necessary repair parts and competent operators are necessary to decrease moving time, now about 300 per cent above normal.

—Abstract of paper by W. H. Morrison, A.P.I. meeting, May 25, 1944, Tulsa, Oklahoma.

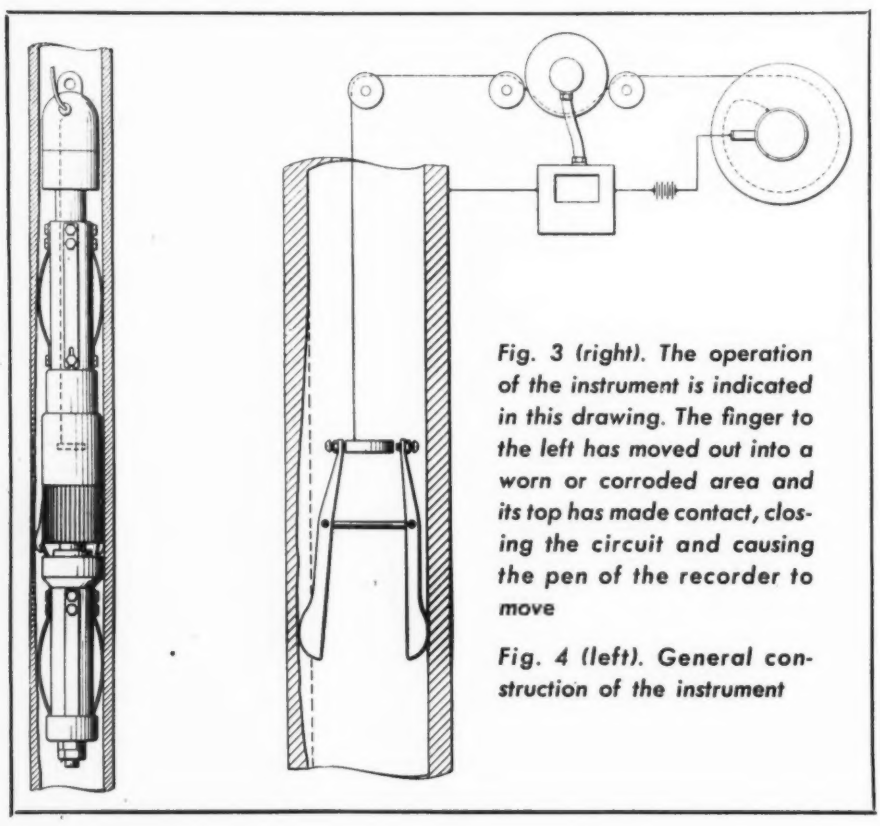

Fig. 3 (right). The operation of the instrument is indicated in this drawing. The finger to the left has moved out into a worn or corroded area and its top has made contact, closing the circuit and causing the pen of the recorder to move

Fig. 4 (left). General construction of the instrument

Exclusion of Water From Wells*

by E. A. Stephenson
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In collaboration with

P. T. Amstutz, Jr.
Standard Oil Company of Ohio

THE expenses involved in lifting the water, separating it from oil treatment to render it chemically inert, filtration, and finally disposal to salt water pits or deep wells, comprise important items in the cost of producing oil. Expenses chargeable to water production should also include corrosion costs of equipment, since the waters are so corrosive in many areas as to call for frequent replacement of tubing and pumps, so that the water contributes a substantial quantity to the overall cost of oil production. On this account, much attention has been given to methods for reducing the volume of water produced with oil, although it is the writers' opinion that engineering progress would have been greatly facilitated if vision had been focused instead on means for early and continued prevention of water influx. If such an objective could be attained, a considerable portion of the maintenance and operating expenses as well as the heavy investment for disposal systems might then be unnecessary.

While the complete elimination of water from all oil wells may not be possible, and in many instances not wholly desirable, the deleterious effects of salt water when present in large quantities are unquestioned. Of the many procedures that have been tried for the purpose of excluding it from wells, some have proved highly effective. Notable among these have been the use of mud-laden fluid and cement slurry pumped into wells under pressure and allowed either to gel or set while the pressure is maintained on the fluid system. Cement has also been pumped through perforations especi-

*Presented before American Petroleum Institute Mid-Continent District Division of Production, Tulsa, Oklahoma, May 25-26, 1944.

Fig. 1

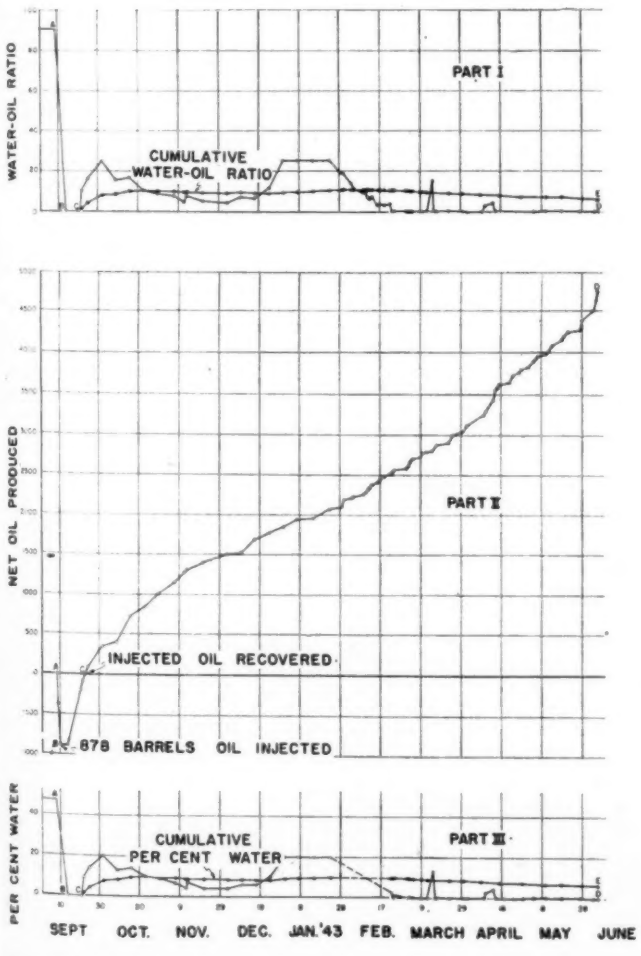
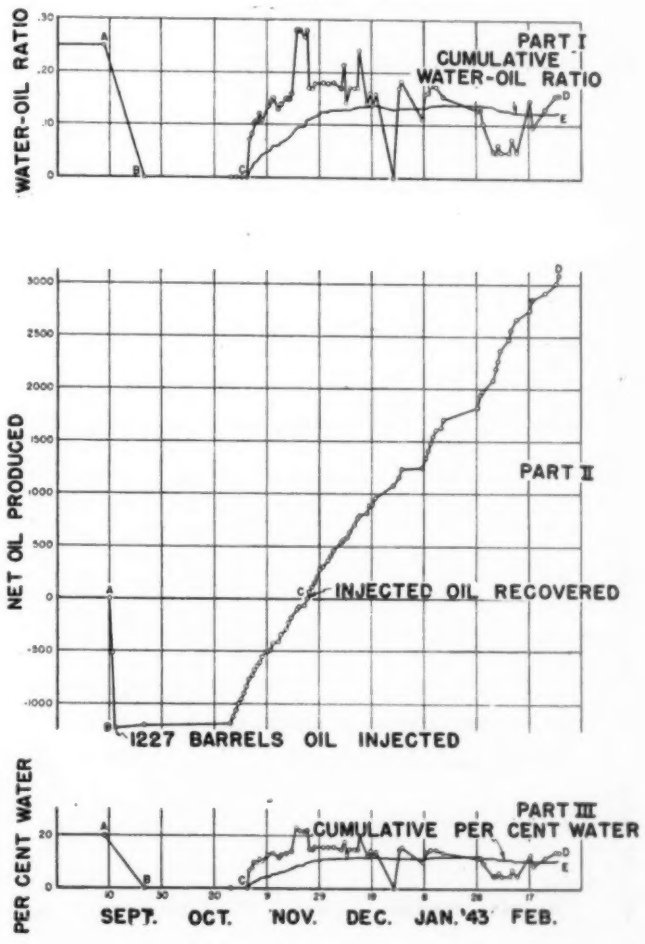


Fig. 2



ally prepared for the purpose. Plugging back to impervious beds, such as thin shale layers, has eliminated the water more or less successfully. Bottom water has been shut off successfully by means of lead wool matted at the bottom of the hole, or by the use of oakum, hemp rope, wooden plugs, or various combinations of all of these. Packers also have proved effective for this purpose. Chemicals which react with water and form impervious sheaths or membranes between the mineral grains have proved beneficial in certain formations and wells. More recently plastic compounds in liquid form have been placed in the bottoms of oil-water wells.[1] The latter form a bond with the walls of the hole and become solid under the influence of the high well temperature.

A careful review of the literature indicates that the basic principle on which all of these processes are founded is the formation of a barrier that is more or less impervious to water. The mutual relation between permeability and saturation points strongly to the conclusion that a method that would effectively reduce the water saturation in the vicinity of wells suffering either from waterconing or normal water encroachment should reduce the quantity of water produced. Dunlap[2] experimented along this line with unconsolidated sands saturated with distilled water, into which kerosine was forced from above, under heads that varied from 4.5 to 17.7 lb. per sq. in.; he found that for water saturations of the order of 40 to 50 per cent the permeability to kerosine was less than 10 per cent of the normal or specific permeability. Injection of the kerosine into the water-saturated sands resulted in a drop of the water-saturation to 50 per cent before any oil came through, i. e., approximately half of the water was expelled by the injected kerosine before the sand became permeable to it. It might appear that a complete reversal of the conditions of this experiment wherein the sand is initially saturated with oil, but water is used as the displacing medium, would produce analogous results, i. e., the sand would be virtually impermeable to the flow of water as long as the oil saturation was maintained at certain values. However, a few such experiments that have been tried by Wyckoff and Botset[3] revealed that no definite build-up of a pressure gradient took place, but that water began to flow out of the oil-saturated sand almost immediately after injection started. Water-saturation continued to remain low and definite channels of water were observed in the flow tube. The preferential wetting of the sand by the water was believed to be responsible for the channels.

In spite of the adverse results of the Wyckoff-Botset experiments, a program was instituted wherein large volumes of crude oil were injected into the bottoms of a group of oil-water wells making various percentages of water from the Arbuckle limestone. No prior information was available as to the surface tension of the oil, or the water, or the wettability of the dolomite grains by either liquid, or the permeability of the rock; (The laboratory work on this phase of the problem is still under way.) neither was the exact pay thickness nor fraction of penetration known. The oil was forced into both oil and water zones under the maximum possible pressure differentials and velocities, after a preliminary saturation with oil of the penetrated section immediately surrounding the well. Relatively small pressure differentials are used at the start followed shortly thereafter by oil at the high pressure differential. The treatment is continued for several hours until the desired volume of oil has been injected.

Thirteen wells whose ages ranged from 3 to 6 years and whose water production varied from 18 to 96 per cent were treated according to this program and as many pertinent facts as possible secured both during and after the injection. Efforts to standardize the procedure were only partially successful due to normal field vicissitudes, such as breakdowns, unforseen mechanical difficulties, shortage of personnel and adverse weather.

A specific objective of the oil treatment is to oil-saturate the water-bear-

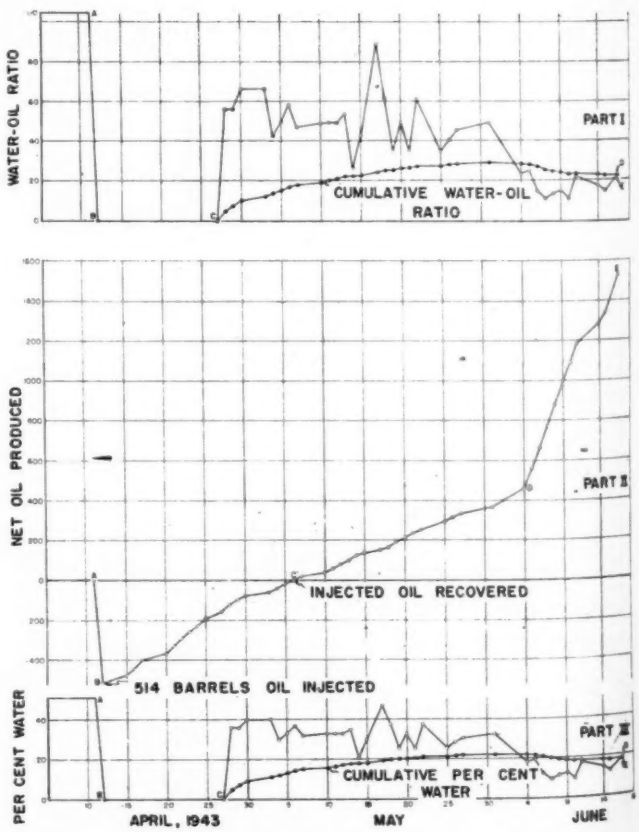
[1]"Use of Plastics in Water Control," D. G. Hefley and P. H. Cardwell, *The Petroleum Engineer*, Vol. 15, No. 3, December, 1943, pp. 51-54.

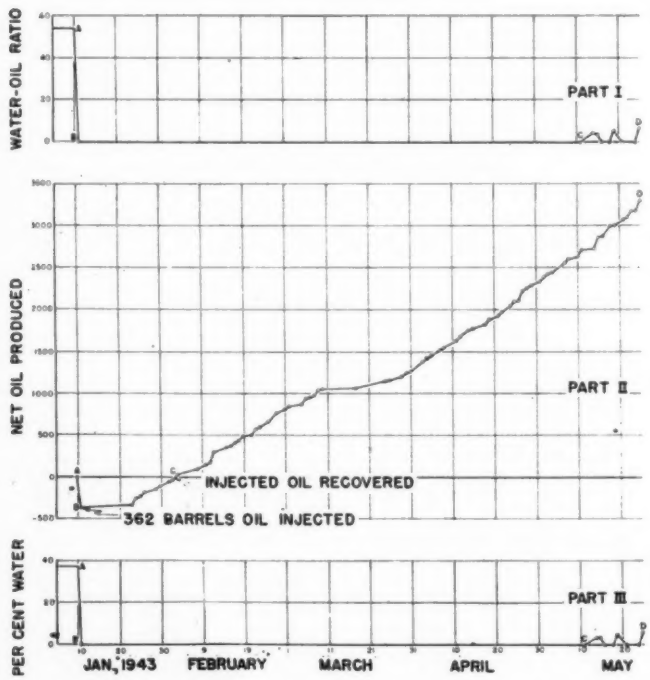
[2]"Influence of Connate Water on Permeability of Sands to Oil," Eldon N. Dunlap, *A.I.M.E. Transactions* (Petroleum Technology), Vol. 127 (1938), p. 214.

[3]"The Flow of Gas-Liquid Mixtures Through Unconsolidated Sands, R. D. Wyckoff and H. G. Botset, *Physics*, Vol. 7 (1936), p. 325.

Fig. 4 (Right)

Fig. 3 (Below)





ing strata contiguous to the well; it is also desirable to stimulate the formation of an oil-water emulsion therein. Practically, this is extremely difficult to accomplish where the sands are very thin, hence the oil and water bearing zones were usually treated as a unit and the proportions of oil that entered the water and the oil-bearing zones were not determined. Injection pressures were maintained as high as possible; the rates used were preferably above any at which wells had heretofore been produced. Enough injection fluid was used to insure that a substantial portion of it entered the water stratum.

A modified form of treatment, and one which is believed to be greatly superior to the above process*, has been developed in which a packer or similar suitable device is so placed near the end of the injection string of pipe that when the device is expanded against the walls of the hole it effectively seals the oil strata above it from the water strata below. A back-pressure valve on the injection string, below the packer, will be opened when the pressure of fluid within the pipe is sufficiently high; the injection fluid will then be ejected directly against the water bearing sand-face, and no significant portion of it will reach the oil pay. The treatment is thus concentrated upon the water-bearing zone, which is forced to accept the treating fluid when the injection pressures exceed the breakdown point. This method requires less oil, a shorter time for treatment, and insures more positive results. It is adaptable to any sands thick enough to permit segregation of the oil and water-bearing zones.

In general, the data obtained during injection consists of: (a) Periodic fluid-level measurements, (b) wellhead pressures, (c) quantity of injected oil, all recorded against time. From this information, together with essential well data, the height of the fluid column, the bottom-hole pressures and the cumulative fluid injected may be computed.

As soon as possible after the injection has been completed, further fluid level measurements are usually taken and the fall of fluid in the casing observed, from which the static bottom-hole pressure may be determined graphically. The special fittings are then dismantled, and the pump again placed in the well and connected. The time required to put the well back on production varies from 2 to 12 days, dependent on availability of labor, mechanical problems, tankage, etc.

The operation of the wells after treatment involves no special procedure or equipment other than liner or insert pumps small enough to handle the reduced volumes of fluid which correspond to the hourly oil production rates in effect prior to the treatment.

If the equation for radial flow be modified so as to include permeability, viscosity, and $\log_e \frac{R_f}{R_w}$ all in one constant M†, it may then be written:

$$Q = M\,t\,\Delta P \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where:

Q = bbl. per hour,
t = sand thickness, and
ΔP = the pressure differential.

The decrease in permeability to water which is brought about by the injection of oil into the water-bearing zone has the same effect as a reduction in thickness of the oil-water producing section; hence, if the same volume of fluid is to be produced per hour as before, the pressure differential must be correspondingly increased. Such an increase is probably impossible without water-coning, since the very presence of the water indicates that either a cone has already been produced and ruptured under the smaller pressure differential which was in effect prior to the treatment, or that water fingering, or bottom-water encroachment has taken place. Theoretically, then the logical step following the oil injection is to curtail the rate of withdrawal so as to avoid an increase in the pressure differential. If such curtailment has for its objective the complete elimination of water, the maximum rate should be limited to that which is equivalent to the quantity of oil withdrawn per hour prior to the treatment. Of the thirteen wells tested by the method above outlined twelve of them fall naturally into three groups. (See Table 1.) The subdivision includes in Group 1 those 5 wells that had been handled according to the theoretical procedure both for injection and subsequent operation. The second group (Group II) includes 3 with high water percentages that had been treated as indicated but whose operating rates were substantially above those conducive to clean oil production. The last group (Group III) embraces 4 wells that were also treated according to the prescribed method but which operated without any reduction in withdrawal rate.

(*Continued on Page 62*)

*This modification is not rigorously correct due to the differences in permeability, saturation, and oil and water viscosity, but is a reasonable approximation and affords a basis for computing withdrawal rates to be used immediately after the treatment.

†Patents pending.

TABLE I

Injection treatment—comparison of results

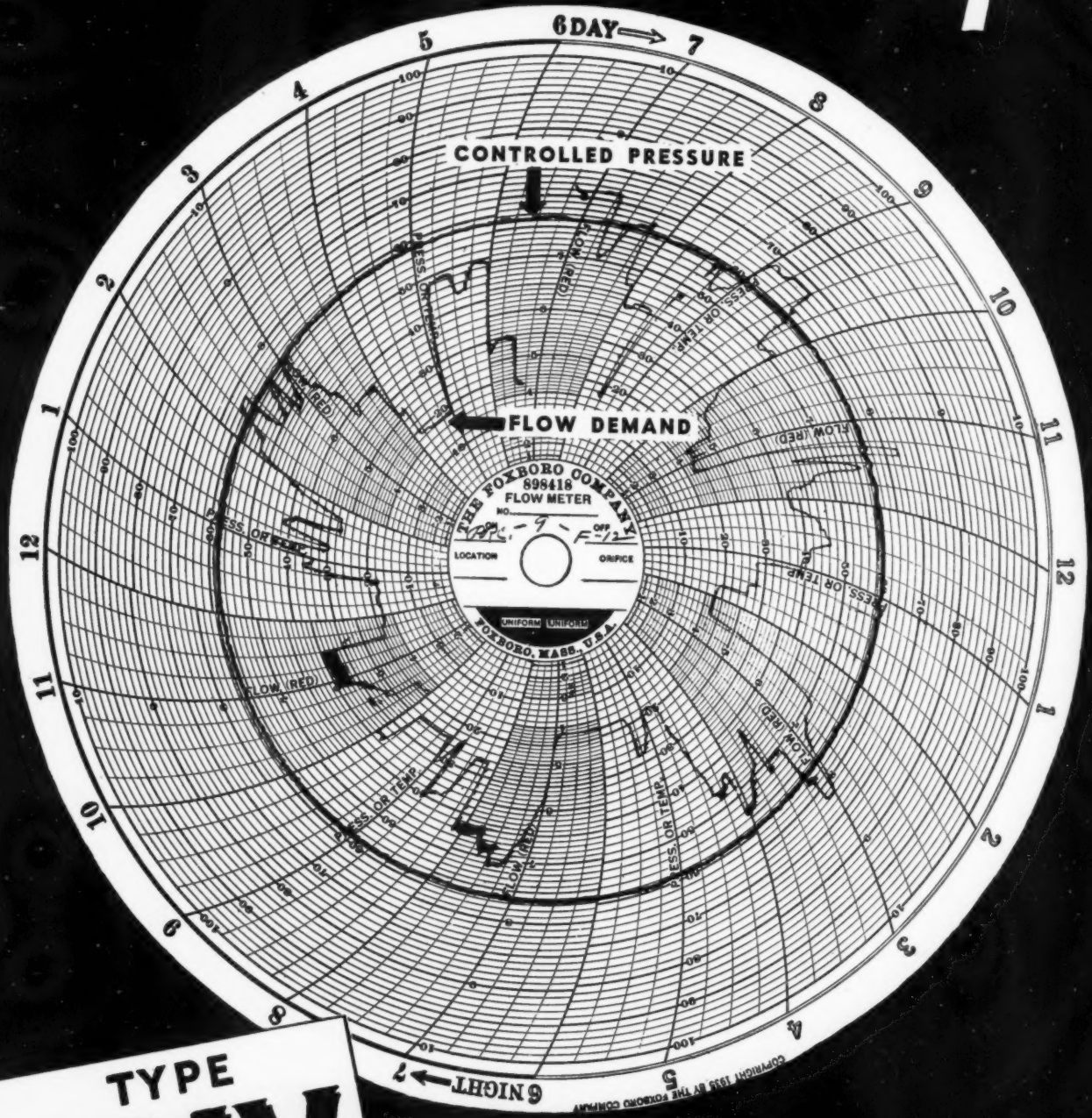
Group I

1	2	3	4	5	6	7	8	9	10	11	12
Well No.	Withdrawal rate prior to treatment, bbl. per hr.	Average per cent water at rate shown in column 2	Withdrawal rate after treatment, bbl. per hr.	Current per cent water, July 1943	Duration of test, months	Total new oil produced, bbl.	Total water produced, bbl.	Expected water production, bbl.	Actual water production expressed as per cent	Reduction in water expressed as bbl.	Ratio of produced water to expected water
1	13.0	47	5.0	0	10	5669	234	5010	3.96	4776	0.047
2	5.6	18	3.6	15	10	5857	902	1286	13.34	384	0.701
3	13.0	35	5.8	8	6	4577	172	2470	3.62	2298	0.069
4	11.0	51	5.0	19	3	2616	527	2720	16.8	2193	0.194
5	13.0	32	6.5	7	2.3	2125	203	1000	8.71	797	0.203
Group II											
6	6.0	92	1.8	87	6	1474	6886	22540	82.30	15654	0.306
7	14.1	96	5.0	95	3	299	3866	18336	92.8	14470	0.211
8	10.0	80	5.0	95*	1.3	285	....	....	....	....	....
Group III											
9	3.0	42.5	3.2	45.9	2.5	2425	2346	2145	49.2	201†	1.094
10	4.3	28	4.3	26.7	2.5	1333	393	576	22.8	183	0.682
11	5.0	18	5.0	16	2.0	3524	582	775	14.2	193	0.751
12	5.0	56	5.0	63	1.5	877	1354	1113	60.7	241†	1.216

*Precise data not available; water has increased.

†Water increased.

For Versatility..



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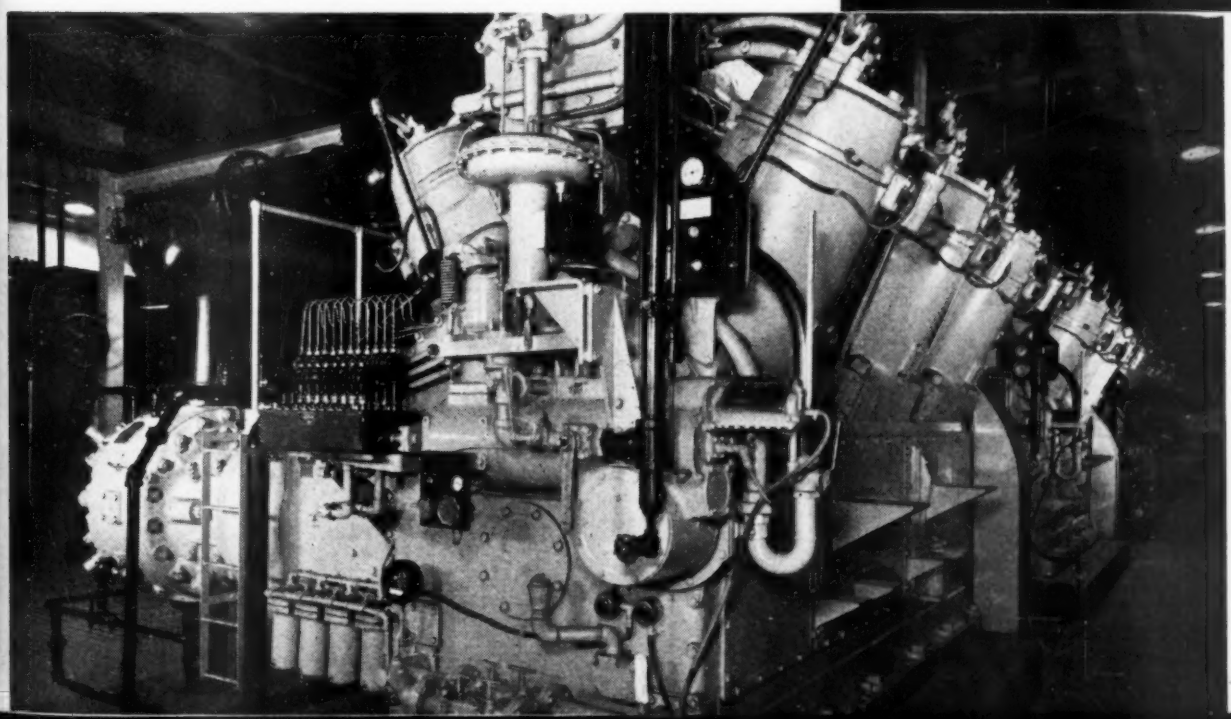

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(*Continued from Page 59*)

Results of the treatment. Group I: In the case of well No. 1, Fig. 1, the water production prior to treatment was 47 per cent and after a lapse of 10 months, is currently zero; the small amount of water (234 bbl.) produced during the early part of the post-treatment period is but 4.7 per cent of the calculated amount that would have been produced had the old water rate continued. The saving in water lifted, during the production of 5669 bbl. of new oil is 5010 minus 234, or 4776 bbl. The well is currently producing no water, hence a complete evaluation of the success of the process is not possible, although it can definitely be considered a very successful result.

Well No. 2, Fig. 2, was making 18 per cent prior to the treatment, and during the 10 months subsequent thereto has produced 5857 bbl. of oil and 902 bbl. of water, or at the rate of 13.3 per cent water. It is currently making 15 per cent water, hence the treatment is only moderately successful, especially in view of the fact that up to the present time the saving in water lifted amounts to but 385 bbl. Prior to treatment, well No. 3, Fig. 3, was producing 35 per cent water; during the post-injection period of 6 months it produced 4577 bbl. of oil, and 172 bbl. of water or at an average rate of 3.6 per cent water. The saving in water lifted is 2298 bbl., but the well is currently making only 8 per cent water, so that complete evaluation of the process is not yet possible, although the results are extremely satisfactory.

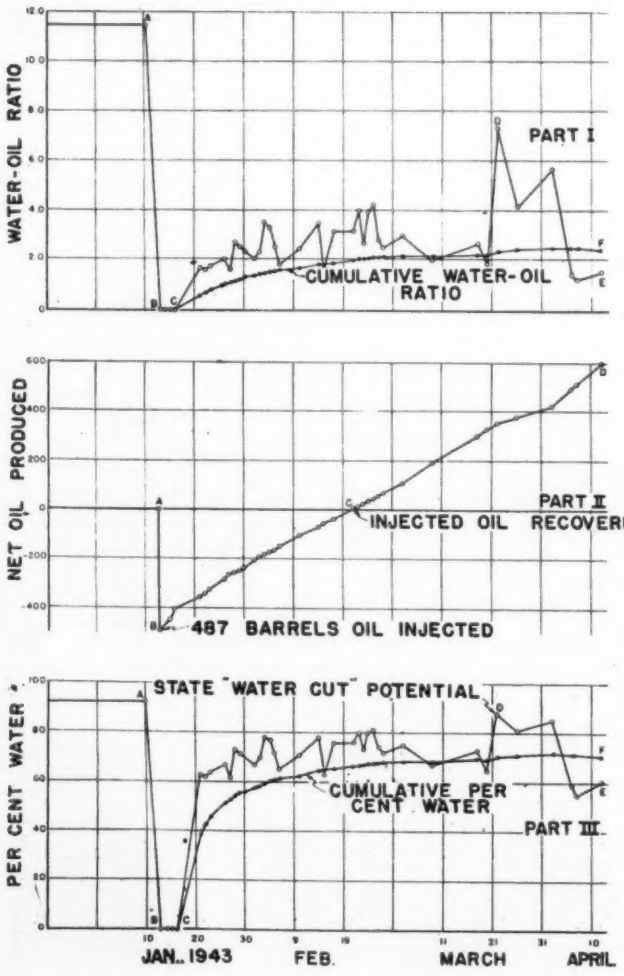
In the case of well No. 4, Fig. 4, it was making 51 per cent water prior to treatment and three months afterward (as of July, 1943) was making 19 per cent water, but the latter was slowly increasing. Since treatment the well has made 2616 bbl. of new oil and 527 bbl. of water. The saving in water lifted is 2193 bbl.

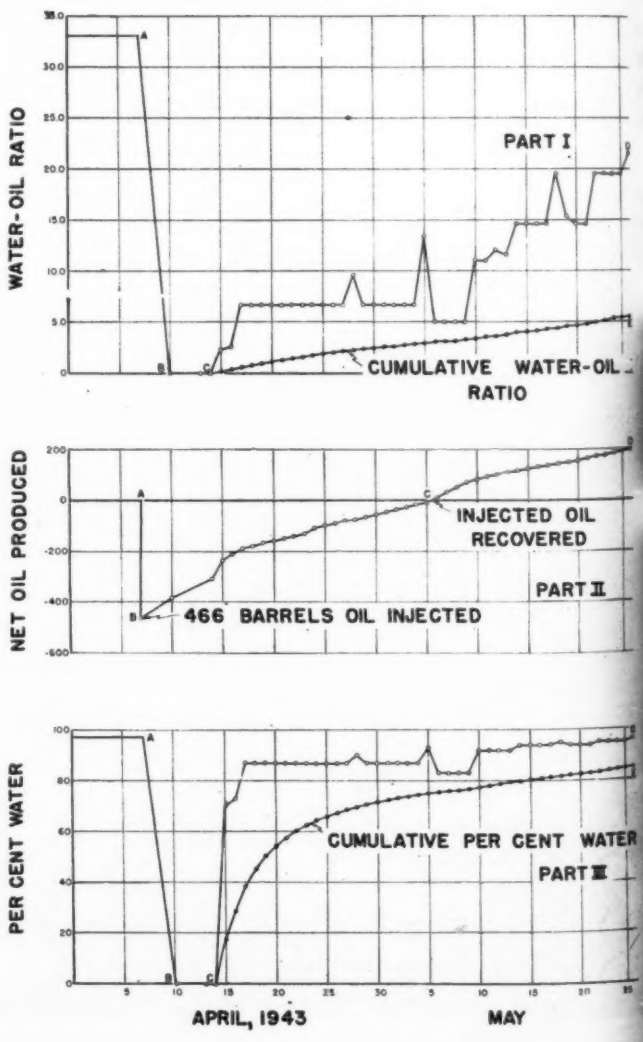
The fifth well, No. 5, was making 32 per cent water prior to treatment, and at the end of 2.3 months was making 7 per cent water, which was gradually diminishing in quantity. Oil production since treatment is 2125 bbl., and the average water production has been 9 per cent. The saving in quantity of water lifted is 797 bbl. The fact that the proportion of water is still declining makes the test appear highly favorable, but it is too early to evaluate the process completely.

All of the above wells were treated and operated according to the engineering principles on which the process is based. The most marked success was attained in wells 1, 3, and 5, in all of which the subsequent water production has been negligible, and all of which are still making little or no water. Such water as has been produced was obtained shortly after the treatment, and has since then declined. The calculated volumes have assumed no increase in percentage, but are based on the proportion of water produced by each well just prior to treatment. Normally, the increase in water production is of the order of at least 1 per cent for each 1000 bbl. of oil produced; hence, the estimates as to water production under old operating conditions are ultra-conservative. The results are summarized in Table 1.

Group II. A second group of wells includes those that were operated at rates of withdrawal comparable or equal to those in use prior to the injection treatment. It includes 3 wells that were producing 80 per cent or more water prior to the injection (Nos. 6, 7, 8); although these were considered dubious prospects from the start, they were

Fig. 5 (Below)
Fig. 6 (Right)





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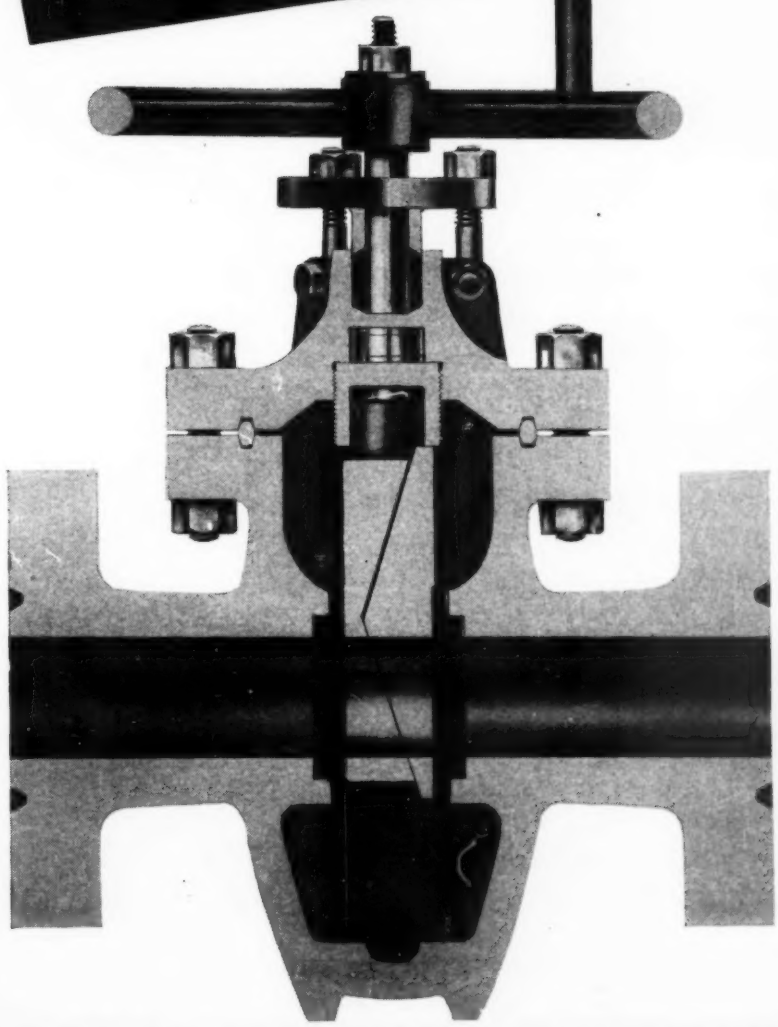
They serve as guides for the full travel of the gate and also carry the spring actuated, triple acting wiper or sealing rings which keep the gate clean, prevent loss of grease from the body and also provide still another effective seal against pressure.

Because the area of these seats is considerably more than that area of the gate exposed to pressure, renewal is seldom necessary. However, because they are renewable, they may, like other parts of the valve, be changed on the lease, and if desired, without removing the valve from the line.

This is another of the several reasons why you may be sure that a W-K-M Valve will always effect a complete shut-off and will always open or close under full rated pressure.



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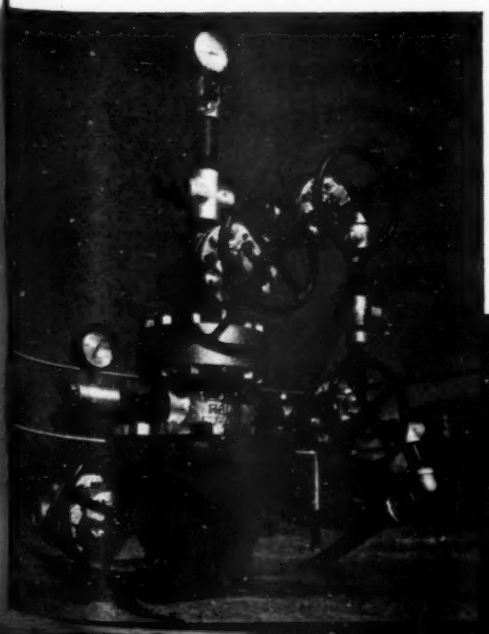


The Valves Make The Tree

nevertheless tested, principally, in an attempt to discover whether or not they would show any response to the treatment and also whether the results, if favorable, would justify the cost. The hourly withdrawal rate was curtailed after the treatment, but it was not cut sufficiently to meet the balance indicated by the equation (1). For example, well No. 6, Fig. 5, made 92 per cent water prior to treatment at a withdrawal rate of 6 bbl. per hr. Due to such a high proportion of water, its calculated water-free rate after treatment should have been but 0.48 bbl. per hr. instead of 1.8 bbl. Well No. 7, Fig. 6, was making 96 per cent water at a withdrawal rate of 14.1 bbl. of fluid per hr. In order to produce water-free oil, its rate should not have exceeded 0.56 bbl. per hr., after treatment; its actual withdrawal rate was 5 bbl. per hr. Similarly, well No. 8, which made 80 per cent water before treatment, when its withdrawal rate was 10 bbl. per hr., should have been reduced to 2 bbl. per hr. after treatment instead of to 5 bbl. per hr.

Practically, the indicated rates for two of these wells are smaller than can be reached with present equipment; hence the obvious conclusion is that wells should be treated long before such large proportions of water are pumped. In spite of these conditions and the apparently unfavorable results of the tests. Wells 6 and 7 each produced, before the water again rose to its pre-treatment percentage, over 14,000 bbl. less water than they were expected to produce at the pre-treatment rate.

Group III. The third group of wells includes four wells whose operating rates after the treatment were either the same as or greater than they were before the treatment (Wells Nos. 9, 10, 11, and 12), Fig. 7. These wells made from 18 to 56 per cent water prior to treatment and as was anticipated, the results are by no means impressive, except to confirm the view as to the need for reduced withdrawal rates, after the injection has been completed, in conformity with sound engineering principles.

A summary of the results of the treatment is presented in Table 1, wherein the wells are grouped according to the above plan.

From the preceding discussion it can be seen that the success of the treatment is dependent upon more than merely injection and saturation with oil of the water-bearing portion of the formation in the immediate vicinity of the well-bore. Accurate measurements of the percentages of water must be secured during normal operation before injection, and for several months afterward; otherwise, the evaluation of the process is utterly impossible. Water should preferably not be forced back into the oil-bearing portion of the formation, the velocity of injection should be as high as can be attained, and the volume of water-bearing formation saturated with oil, should be sufficient to form a substantial barrier to water influx. The initial rate of withdrawal of total fluid immediately after treatment should be low and should not exceed the actual daily volume of oil which was produced by the well when operated normally prior to the injection; this low rate of withdrawal should be continued well beyond the time when recovery of the equivalent volume of injected oil has been achieved. Immediate attempts to operate the well at the same or even approximately the same rate as before the injection will render the success of the procedure void, since such a step violates the fundamental engineering principles on which the process is based. Early production of water need cause no special alarm, since water may come from the oil zone, especially if prior to treatment a column of water was standing in the well, or connate water may continue to enter the hole. Operators are usually inclined to be discouraged when water is produced soon after the injection and tend to speed up the

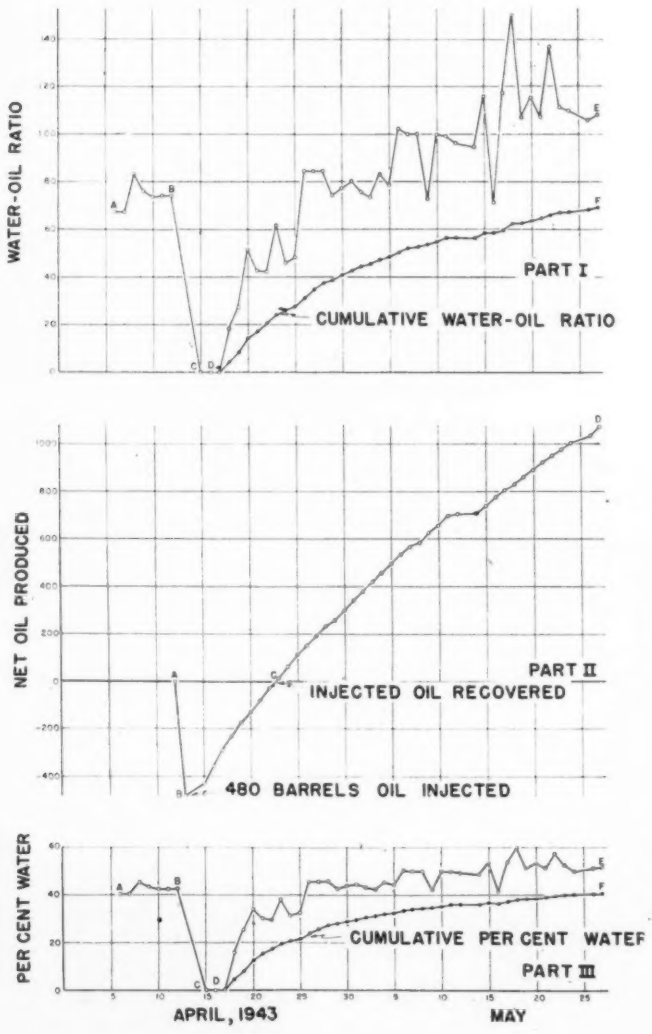
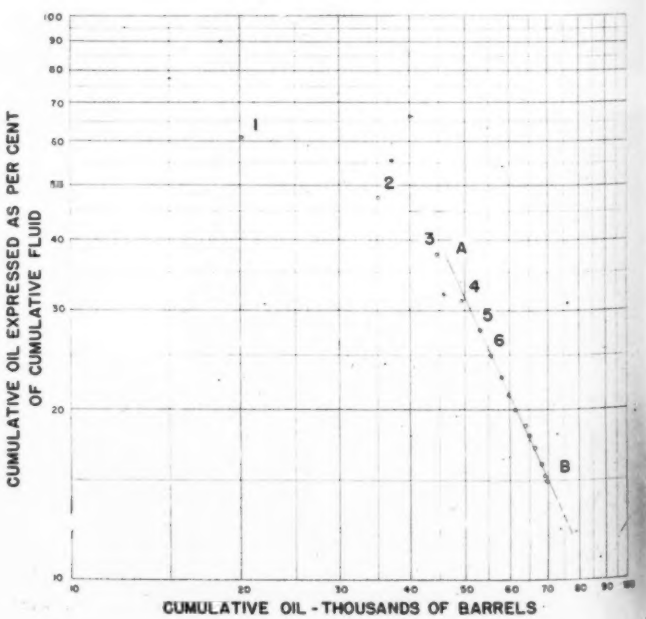
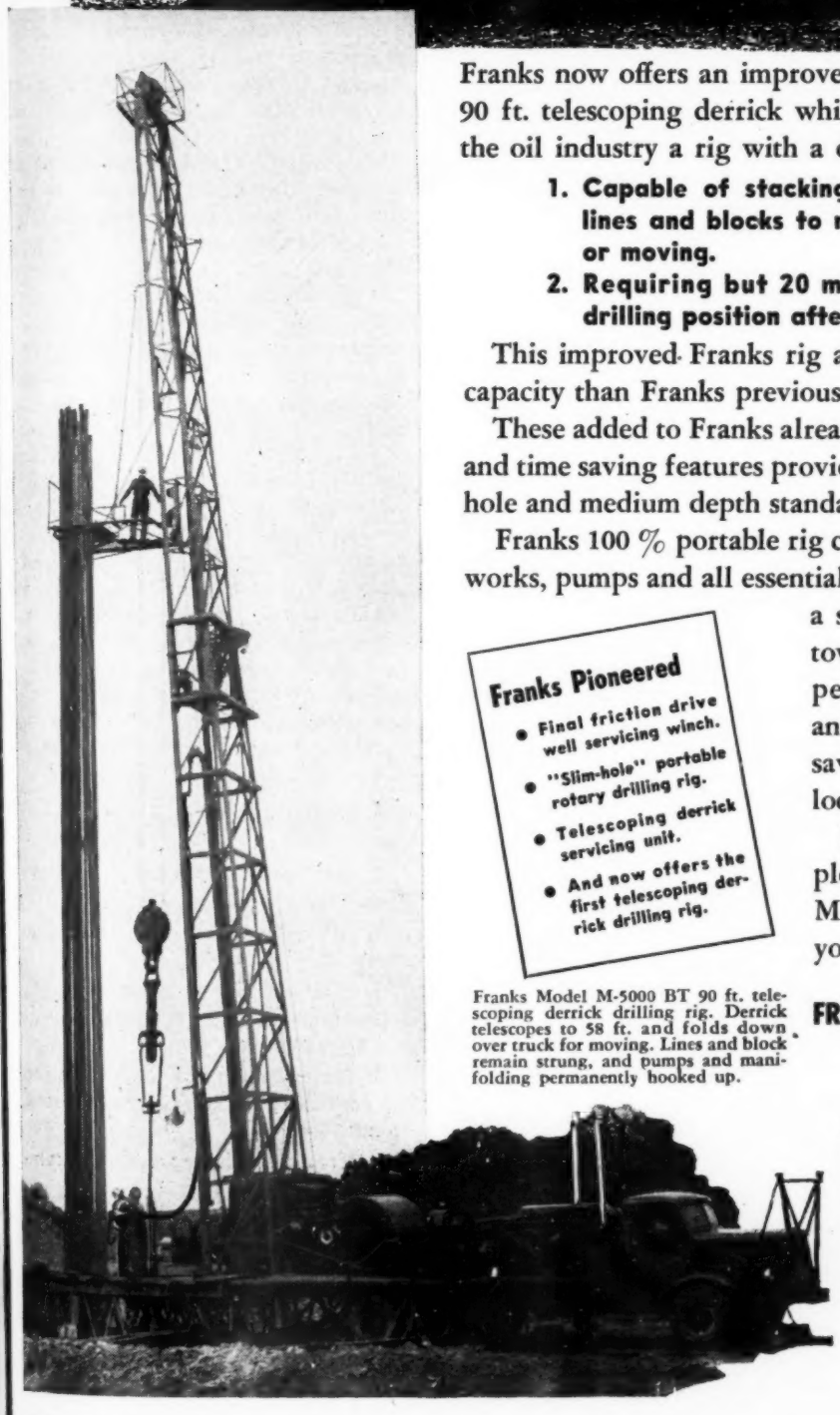


Fig. 7 (Left)

Fig. 8 (Below)



A PORTABLE DRILLING RIG with a 90ft. TELESCOPING DERRICK



Franks now offers an improved 100% portable drilling rig with a 90 ft. telescoping derrick which for the first time in history gives the oil industry a rig with a derrick:

1. **Capable of stacking doubles and permitting the lines and blocks to remain strung whether drilling or moving.**
2. **Requiring but 20 minutes to raise and extend to drilling position after reaching location.**

This improved Franks rig also has a 20 percent greater drilling capacity than Franks previous truck-mounted drilling rigs.

These added to Franks already well known and field tested money and time saving features provides a rig second to none for deep slim-hole and medium depth standard drilling.

Franks 100 % portable rig containing derrick, power plant, draw-works, pumps and all essentials compactly unitized and mounted on a single truck saves in rig-up and tear-town time; eliminates cost of erecting permanent derricks; saves fuel, water and labor; drills as fast, with greatest saving over any other rig in location-to-location moving.

Franks Pioneered

- Final friction drive well servicing winch.
- "Slim-hole" portable rotary drilling rig.
- Telescoping derrick servicing unit.
- And now offers the first telescoping derrick drilling rig.

Franks Model M-5000 BT 90 ft. telescoping derrick drilling rig. Derrick telescopes to 58 ft. and folds down over truck for moving. Lines and block remain strung, and pumps and manifolding permanently hooked up.

Before you buy a rig write for complete specifications on Franks Model M-5000 BT and check for yourself how you can further reduce drilling costs.

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pumping rate; they must be cautioned repeatedly against such a step.

The duration of the beneficial effects of the treatment still remains to be determined but may extend well beyond a full year, and certainly promises the exclusion of thousands of barrels of water per well per year. Finally, the normal encroachment of water which accompanies the depletion of the reservoir oil will tend to gradually displace or bypass the injected oil. Operation of the wells at excessive rates of withdrawal will also invite the incursion of water, and in both of these cases the proportion thereof may ultimately equal or exceed that delivered by the well prior to treatment.

Evaluation of the benefits of the treatment must primarily be made on an economic basis; unless the value of the results exceeds their cost, the treatment is unwarranted. Since the exclusion of the water is probably not absolutely permanent, at least insofar as the entire future life of the well is concerned, it is necessary at present to evaluate the process at the various stages in its history. This is best done by computation of the volume of water which would have been lifted had no remedial measure been adopted, and then comparison of this quantity with the actual volume of water produced with the oil. A similar comparison is then made of the amount of oil that would have been produced under the old method of operation with that which was produced under the modified rate of production. If the oil production has declined this may offset any economies introduced due to the reduction in the quantity of water lifted, but if the volume of oil is either equivalent to, or greater than that which would have been produced, then the evaluation is largely a function of the water production data. Lifting costs alone do not afford a sufficient basis for comparison, but the disposal costs and the reduction in expenses which accompany subdued corrosion of all pumping equipment, should all be taken into consideration. No provision was made in Table 1, column 9, for the inevitable increase in percentage of water under the pre-treatment operating program, but such an increase could be calculated if the water-oil data were accurately measured and preserved. A trend towards the acquisition of such data has been observed.

In this connection, it is essential for the producer to give consideration to the question of immediate returns on his capital outlay, as compared with a long term yield at perhaps a lesser rate but with an ultimate increase in total barrels of oil recovered. These considerations necessarily involve a compromise between maximum profits, and long term profits, or between the quick recovery of a smaller number of barrels of oil from a particular property, as contrasted with a larger number of barrels distributed over a longer period; certainly the company with an integrated system and widely held properties is in a more favorable position to prolong its maximum recovery over a greater period of years than the small concern such as is represented by an ownership faced with the urgency for a more rapid payout.

TABLE 2

Oil-water production data

(Well A)

Year*	Cumulative oil production, bbl.	Cumulative water, bbl.	Cumulative fluid, bbl.	Cumulative oil expressed as per cent of cumulative fluid
1935 a	.....	.....	.....	
b	20,389	13,124	33,516	60.8
1936 a	35,473	38,702	74,175	47.8
b	44,570	74,749	119,319	37.4
1937 a	49,166	108,550	157,716	31.2
b	52,982	138,228	191,210	27.7
1938 a	55,694	167,361	223,055	24.9
b	58,100	198,257	256,357	22.7
1939 a	59,888	222,350	282,238	21.2
b	61,585	247,364	308,949	19.9
1940 a	63,696	275,563	339,259	18.8
b	65,005	295,182	360,187	18.1
1941 a	66,226	320,960	387,186	17.1
b	67,844	354,874	422,718	16.1
1942 a	69,042	386,500	455,542	15.2
b	69,377	401,617	470,994	14.7
1943 a	69,381†	402,567	471,948	14.7

*a–first half of year.

b–second half of year.

†Well abandoned January 1943.

‡Prior to the first appearance of water the well had produced 71,746 bbl. of oil in 10 months. The maximum withdrawal rate reported was 51.4 bbl. of oil per hr.

Nor can the interest of the public in this connection be ignored, especially since the known petroleum reserves of the United States are *pitifully* small as compared with the other sources of energy. The magnitude of these reserves affords even less cause for complacency when the acceleration in rate of consumption is seriously regarded. On the other hand, the spread of proration, and enhanced public consciousness of the importance of recovering the largest possible proportion of the underground reserves without undue hardships upon the producers have done much to discourage wasteful production practices and stimulate the application of engineering technique to oil field operations.

One other phase of the study that has an important bearing on the probable value of the injection treatment, is the effect of the latter on the ultimate recovery of oil. It is too early as yet to determine just what the answer to this question may be, but there are good grounds for the expectation of an increase in ultimate recovery. In order to determine the above with any degree of accuracy, it is first imperative that estimates be made of the expected recovery under the old operating methods, which have all been characterized by a gradual increase in the proportion of water.

No generally acceptable method for such estimates is known, but one is hereby proposed that attempts to forecast the recovery of oil under the old methods. All oil production prior to the influx of water is ignored. After water appears a log-log chart is constructed on which the ratios of cumulative oil to cumulative fluid, (i. e., oil and water combined) as computed semi-annually, are plotted as ordinates against cumulative oil as the abscissa. More or less satisfactory data were available for only a few wells, but for those studied, such plots are practically straight lines after the second year of water production, though the inaccuracy of the usual water-oil data throws some doubt on the general validity of the estimates. (See Table 2.) One such graphic chart is presented in Fig. 8. The slope of the line A-B is definitely established by the end of the third year of water production (See points 5 and 6). In some cases it can be determined even earlier. The limiting value of the water-oil constitutes an economic question dependent principally on the prices of oil and the cost of production. In the case presented, the limiting value for the water-oil relation is 98.5 per cent water and 1.5 per cent oil. The latter well has since been abandoned at that limit, which checks very well with the graphic as well as with the mathematical analysis. Once such a method as this has been more fully developed, it may become possible to determine whether or not the treatment herein described insures an increase in recoverable oil.

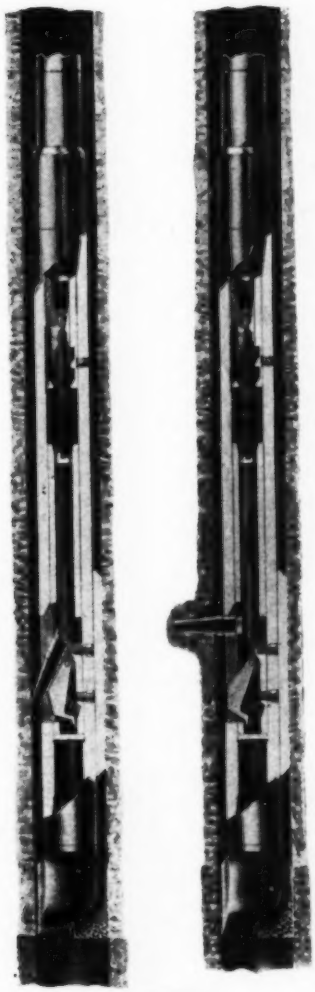
Summary. The merits of the water exclusion treatment may be summarized as follows:

1. Lower lifting costs per barrel of oil.
2. Reduced investment in salt water disposal equipment.
3. Saving in wear on pumping equipment.
4. Curtailment of corrosion and its attendant expenses for maintenance and replacements.
5. Reduction in cost of treating oil since much clean oil is produced instead of emulsion.
6. Treatment is relatively inexpensive.
7. Practically impossible to damage a well by this procedure.
8. Readily adapted to successive low-cost applications as bottom or edge water encroachments make repeated treatments desirable.

—— ☆ ☆ ☆ ——

THEY'LL MAKE A WELL

Hunt Side Wall Cores Said So!



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Cities Service Lake Charles Refinery

Elapsed time was 21 months for completion of huge project augmenting the nation's 100-octane gasoline and synthetic rubber program

SINCE before Pearl Harbor, when Hitler's hordes spread terror throughout all Europe, and since that day of infamy when the self-styled Sons of Heaven wrote the blackest page in all world history with the life blood of innocent men, the American petroleum industry has been under a challenge. That challenge was—and still is—to expand its plant facilities beyond all previous concept for the all-out production of super-octane aviation gasolines, for B-B charge for a newly born synthetic rubber industry, for the production of toluol through synthesis of petroleum, for better lubricants and a host of other products less spectacular in their wartime applications but nonetheless vitally essential to the successful prosecution of the war.

JOHN H. KUNKEL

That challenge to perform these feats was not without imposing conditions. The accomplishments had to be achieved in the face of a manpower shortage of tremendous proportions and a material and equipment shortage without parallel.

How well this industry accepted that challenge forms a brilliant chapter in this war's history of home front activity. The American petroleum refining industry as personified by the highest and the humblest of its workers has responded magnificently. Its men of management, its technologists, its engineers and draftsmen, its office workers, its refinery officials, its skilled workmen and common laborers have combined brains and brawn, skills, abilities and muscle to perform miracle after miracle in the discharge of that challenge.

I have just seen such a miracle and this is its story. This is the story of the miracle of Lake Charles, Louisiana. It is the story of the men who performed it and the stuff from which it was fashioned. This is the story of the new Cities Service Refining Corporation's wholly-financed and owned refinery named the Tutwiler refinery in honor of the corporation's president, and the new Cities Service Refining Corporation-managed butadiene plant both now fully on stream on the banks of the Calcasieu River 6 miles from Lake Charles, Louisiana.

Webster defines a miracle as: "A wonder or a wonderful thing; a marvel." Can less be said than that it is a wonderful thing — a marvel — when a relatively useless 2500-acre tract of land stands tree-studded in September, 1942, and, only 21 months later, that same tract of land stands studded with the lofty towers of a giant new refinery, complete from crude storage to finished products storage tanks with all that goes between? Certainly this falls well within the limits of Webster's definition when this chronology is considered:

September, 1942—ground broken.

December 5, 1943—the first unit of the basic refinery consisting of a 35,000 bbl. per day crude oil distillation unit with all auxiliaries and utilities went on stream.

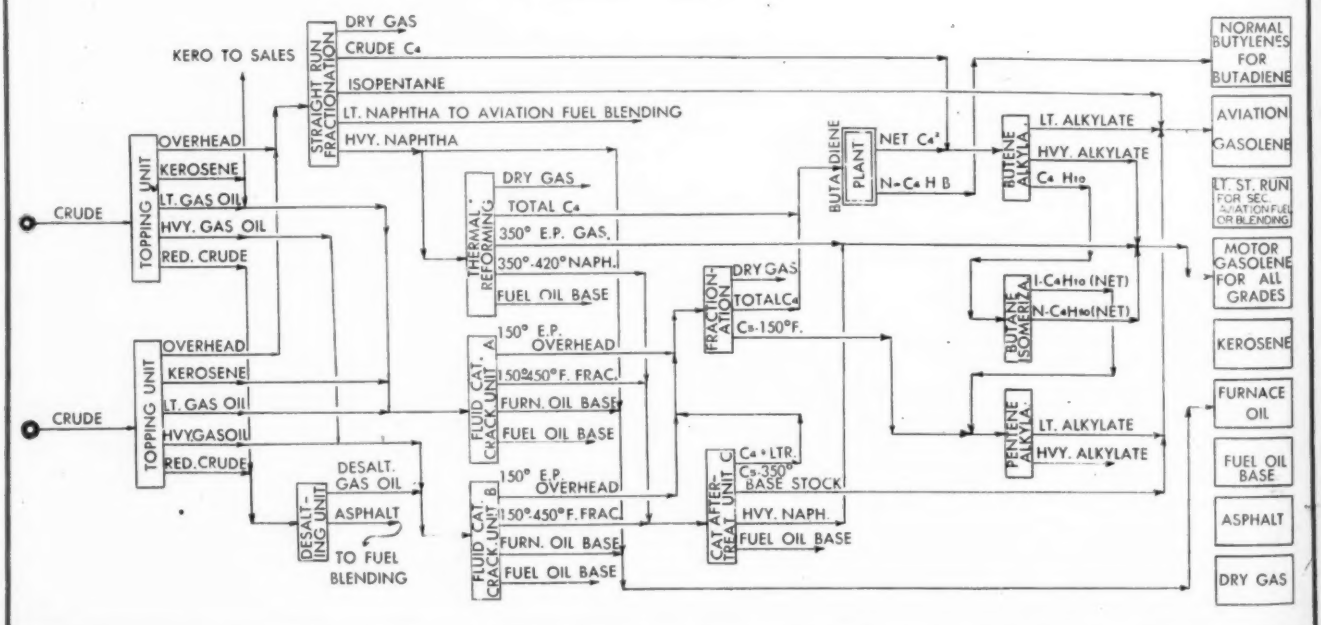
March 5, 1944—7 basic processing units in addition to 6 low-pressure steam boilers and 2 high-pressure steam boilers, one 25,000-kva. turbo-generator together with distribution pipe lines, manifolds, tankage, tanker docks, oil separators, and other auxiliaries and utilities went on stream.

May 11, 1944—second fluid catalytic cracking unit and deasphalting and desalting unit on stream.

May 24, 1944—second topping unit on stream.

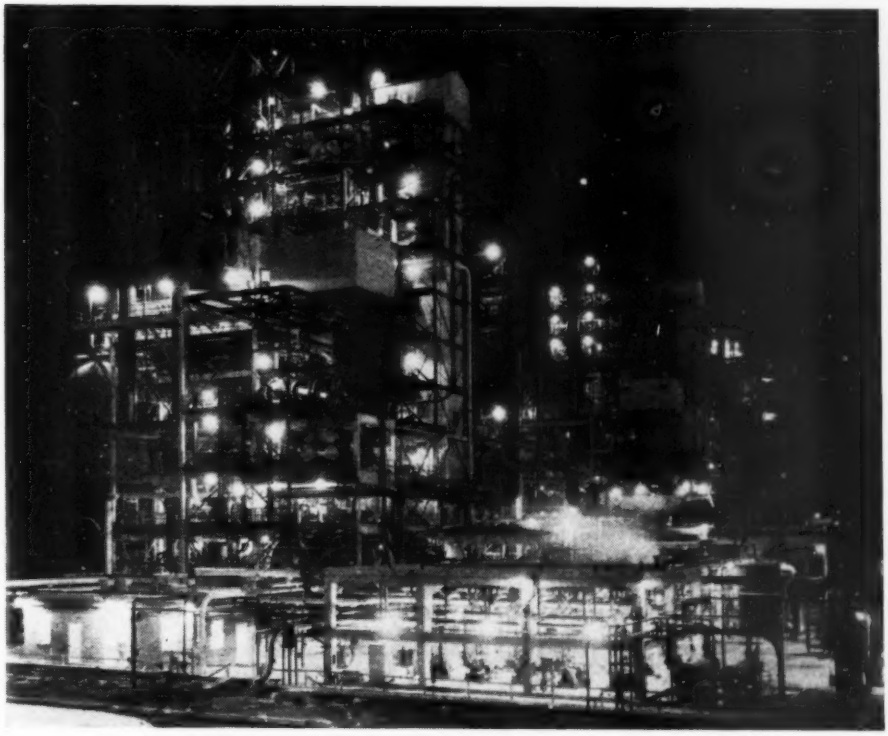
June 8, 1944 — thermal reforming unit on stream.

Products Flow Sheet



...nd Butadiene Plant Now on Stream

by John H. Kunkel
Refinery Editor



Night scene catalytic cracking units "A," "B," and "C"

June 10, 1944—the tenth day of the 22nd month after ground breaking, the entire refinery is fully on stream with the third fluid catalytic cracking unit, second alkylation unit and butane isomerization unit in full operation.

And the stuff from which this miracle was fashioned is a total of more than 25,000,000 man-hours directly expended in engineering and construction to which must be added an additional tremendous volume of man-hours expended in designing, fabricating, and transporting the material and equipment each piece of which is an essential part of the whole.

Table I gives some concept of the feats performed in the creation of this miracle as well as its results.

To make this miracle possible, the Cities Service Refining Corporation was formed June 2, 1942, as a subsidiary of the Cities Service Company to build and operate the refinery, 100 per cent financed and owned by it, and to build and operate the adjoining butadiene plant owned by the Defense Plant Corporation.

Refinery Site

The site of the refinery is a 2500-acre tract, of which the present, or basic refinery, occupies 550 acres. It is located on the west bank of the Calcasieu River 6 miles southwest of Lake Charles. In purchasing 2500 acres, ample land is available for future expansions.

The site of the refinery, the soil of which is a clay-sand mixture, is unique in that it is the west bank of a river much older, wider, and deeper than the Calcasieu. The bank of the old river is 20 ft. higher than the Calcasieu and there are those who, with much foundation, are of the opinion that this older river was once the Mississippi. The Calcasieu River is navigable by ocean-going tankers and it empties into the Gulf of Mexico. The water of the Calcasieu is clean and practically free of solvents, a fact contributing much to refinery operations.

Refinery Units

The basic refinery, as the unit now on stream is termed, is designed for a throughput of 80,000 bbl. per stream day of crude. At the time of this writing, it is running at 50,000 bbl. per day and indications are that it will exceed its design throughput by 30 per cent.

Its end products are: 100-octane aviation gasoline, secondary aviation gasoline, butane-butylene charge for the butadiene plant, motor gasolines, kerosine, furnace oil, fuel oil, and asphalt.

The basic refinery consists of two topping units, three fluid catalytic cracking units, two sulphuric acid alkylation units, a desalting and deasphalting unit, a straight-run gasoline fractionating and thermal reforming unit, a gasoline recovery and fractionation unit, a treating plant, an acid plant, and an ethylizing plant.

Supporting units are a power plant consisting of two high-pressure boilers each generating 325,000 lb. per hr. of superheated steam at a pressure of 825 lb. per sq. in. gauge and a temperature of 850 °F., six low-pressure boilers with 4 generating 120,000 lb. per hr. each of steam at a pressure of 250 lb. per sq. in. gauge and 2 generating 200,000 lb. per hr. each at the same pressure, and 2 bleed-type turbo-generators each of which generates 31,250 kva. (25,000 kw.) of which less than half is used in the refinery with the balance going to the butadiene plant and a nearby copolymerization plant.

Other supporting units are a pilot plant, a chemical laboratory, a change house, a cafeteria, an administration building, machine shops, and garages.

Storage facilities include 18 cone roof crude storage tanks, 11 having a capacity of 80,000 bbl. each and 7 with a capacity of 55,000 bbl. each. There are 66 intermediate products spheroids and storage tanks of various capacities and 15 finished products storage tanks each having a capacity of 100,000 bbl. equipped with cone or floating roofs as required by the products stored. Shipping facilities include 3 wharves to accommodate ocean-going tankers, 4 dual carloading racks each accommodating 28 cars at one time, and pipe line facilities to allow pumping of products directly to the War Emergency Pipelines' "Little Big Inch" pipe line for transport to the east coast.

The contract for engineering, designing, and constructing the entire refinery and the adjoining butadiene plant was awarded to the M. W. Kellogg Company. Subcontractors for the engineering design of the power house were Gibbs-Hill, while the acid plant was engineered and designed by the Chemical Construction Company. The architectural design of the buildings

was done by John W. Harris, Associates.

Topping Units

Crudes are received at the refinery by barge, tanker, and pipe line and pumped to crude storage. Table 2 details data concerning the crudes processed. Crude is charged from storage to two identical topping units and enters each unit in two parallel streams through 2 electric-driven centrifugal pumps each having a design discharge pressure of 600 lb. per sq. in. gauge, the streams discharging at a pressure of 585 lb. per sq. in. gauge at a temperature of 85° F. Both streams then pass through a tubular exchanger for heat exchange against the reflux from the top tray of the unit's crude fractionation column, the streams emerging therefrom at a temperature of 260°F. This exchanger contains 580 steel tubes ¾ in. by 16 ft. in length. The exchanger is designed for a duty of 49,000,000 B.t.u. per hr., the mean temperature difference being 66.4°F.

The temperature of the crude streams is now further increased to 325°F. by exchange against the crude fractionating tower intermediate reflux. This tubular-type exchanger is designed for a duty of 27,500,000 B.t.u. per hr. and contains 580 steel tubes 1¼ in. by 16 ft. in length, the mean temperature difference being 68.6°F.

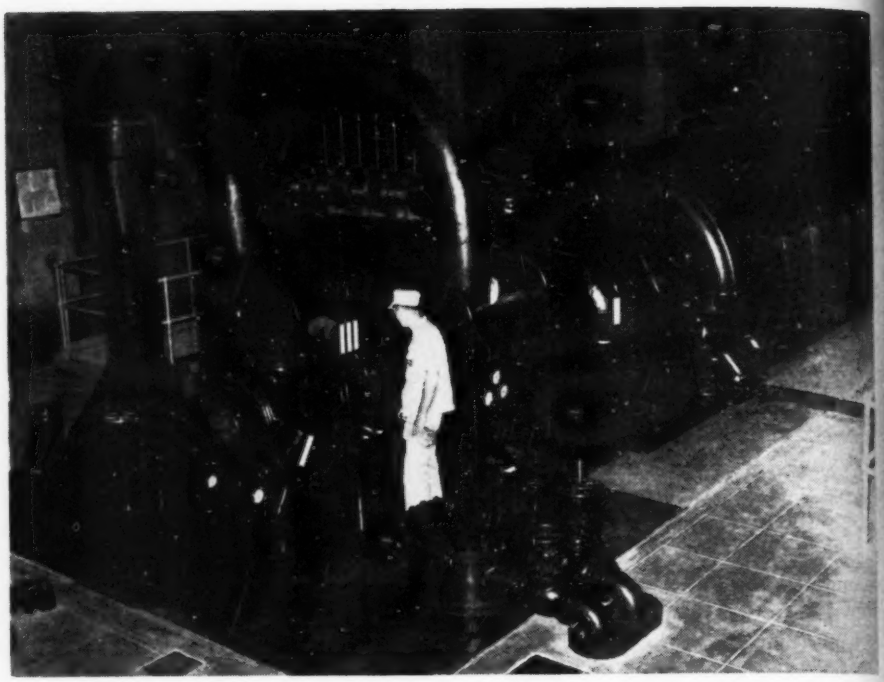
Tertiary temperature increase of both streams occurs by exchange against the heavy gas oil stream leaving the bottom of its stripper in which the crude temperature is elevated to 380°F. This tubular exchanger contains 580 steel tubes 1¼ in. by 16 ft. in length. It is designed for a duty of 8,000,000 B.t.u. per hr., the mean temperature difference being 105°F.

The final exchange, before the feed streams enter the furnace, is against the reduced crude from the crude fractionator bottom. In this exchange, the temperature of both crude streams is raised to 395°F. This exchanger is designed for a duty of 29,000,000 B.t.u. per hr., the mean temperature difference being 134°F. It contains 580 steel tubes, 1¼ in. by 16 ft. in length. From it the streams are fed to the crude furnace at a pressure of 180 lb. per sq. in. gauge.

The furnace is a Kellogg unit, gas-fired, containing all floor burners. It has 3 radiant sections and 1 common convection section for preheating. There is a steam superheater coil at the top of the convection section.

The furnace is designed for a normal duty of 150,000,000 B.t.u. per hr., the normal heat liberated being 215,000,000 B.t.u. per hr., the overall efficiency being 69.73 per cent lower heating value. The total normal fuel fired is 10,450 lb. per hr. of gas having 20,560 B.t.u. per lb. lower heating value. Flue gas leaves the furnace at 950°F. with 40 per cent excess air. The unit has a total heating surface of 16,150 sq. ft. and contains 168 tubes of varying dimensions. The draft control is manual.

Superheated steam for stripping is supplied by the coil at the top of the convection section. This is designed for a capacity of 4600 lb. per hr. of dry steam at a temperature of 700°F. and a pressure of 20 lb. per sq. in. gauge. Four streams in parallel enter at 235°F.



25,000-kw. turbo-generator, power house

TABLE I

A few of the highlights about the great Cities Service refinery and butadiene plants near Lake Charles, Louisiana

1. More than two and one-quarter million tons of dirt were removed in dredging.
2. More than 1,200,000 tons of dirt were excavated for foundations.
3. More than 150,000 cubic yards of concrete and more than 3500 tons of reinforced steel were used.
4. More than 1,500,000 board feet of lumber was reclaimed from the trees cleared from the plant site.
5. Fifteen miles of improved roads are within the plant site.
6. Fourteen miles of railroads are within the plant site.
7. More than 1500 major high precision instruments are used in controlling operations.
8. Largest two-stage absorption type refrigeration plant in the world manufacturing more than six and one-half million pounds of refrigeration per day. This is sufficient to supply ice to several cities such as Cleveland and Baltimore.
9. An electric power plant of 50,000-kw. capacity, which is large enough to furnish electricity to a city such as St. Paul, Omaha, or Akron.
10. Uses more than 43 million gallons of water per day or more than enough to supply the residential requirement of the city of Chicago.
11. Will process 100,000 bbl. of crude oil per day.
12. Has more than 500 electric motors.
13. Will produce 37 intermediate and finished petroleum products, all vitally important to the war effort and as major war products produces more than 300,000,000 gal. per year of 100-octane aviation gasoline—enough fuel to put 1000 bombers over Berlin every day.
14. Will produce approximately 60,000 tons of butadiene per year for the manufacture of synthetic rubber, or approximately 10 per cent of the pre-war rubber requirements of the United States.
15. More than 700 pumps used in the operation.

Crude Fractionation

At a pressure of 21 lb. per sq. in. gauge and at a temperature of 717°F. the two feed streams are fed to the bottom or flash zone of the crude pre-fractionation tower. This tower is 90 ft. high by 19 ft. I. D. with a reduced diameter stripping section in the base measuring 14 ft. 6 in. by 9 ft. I. D. The fractionating section has 30 trays on 30-in. centers and the bottom stripping section contains 3 trays on 30-in. centers. The design pressure of the tower is 35 lb. per sq. in. gauge. The bottom temperature is 710°F. and the top temperature is 260°F. A 3-section side stream stripper measures 48 ft. by 6 ft. I. D. and each section contains 4 trays on 30-in. spacing.

The overhead product from the crude tower is 360°F. end point gasoline, which after leaving the column, is heat exchanged against itself after first passing through the exchanger at 260° F., thence through a water condenser and into a gas separator, dry gas from which goes to plant fuel, and the

(*Continued on Page 74*)

CLARK "ANGLES"

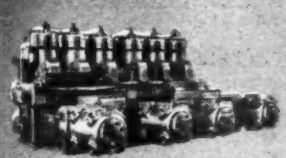
in giant Cities Service 100-Octane and Butadiene Plant

One of the world's largest Hi-Octane and Butadiene plants . . . after being constructed to a Master Plan, new from the ground up . . . is now in operation by Cities Service Oil Company, at Lake Charles, Louisiana.

The project is in reality two integrated plants . . . a 100-Octane refinery owned by Cities Service, and a Butadiene plant owned by the Government but operated by Cities Service. The latter will produce one-tenth of the nation's Butadiene. The former will produce enough Hi-Octane Gasoline to send 1,000 bombers over Germany every 24 hours.

The equipment of these plants represents the very latest improvements, discoveries and inventions in their fields. We believe it significant that 12,600 H. P. of CLARK 2-cycle "Angle" Compressors has been installed. Two of the CLARK installations are here shown . . . a 2,400 H. P. battery in the "A" Cracking Plant, and a 2,400 H. P. battery in the "A" Alkylation Plant.

CLARK "Angles" are delivering their amazing "continuous performance" throughout the Hi-Octane industry.



CLARK 600 HP
Gas-Driven "Angle"

CLARK BROS. CO., INC. . . . OLEAN, NEW YORK, U. S. A.

Export Offices: 30 Rockefeller Plaza, New York. Domestic Sales Offices and Warehouses: Tulsa, Okla.; Houston, Texas; Chicago, Ill. (122 S. Michigan Av.); Boston, Mass. (Park Square Bldg.); Huntington Park, Calif. (5715 Bicket St.). Foreign Offices: London, England; Avda Roque Saenz Pena, 832, Buenos Aires.

CLARK

ONE OF THE DRESSER INDUSTRIES

SETS THE PACE IN COMPRESSOR PROGRESS

(*Continued from Page 70*)

liquid stream is pumped through the exchanger mentioned. Finally at a temperature of 80°F. the gasoline and lighter forms feed for the straight-run fractionating unit.

The bottoms from the crude tower are reduced crude, which is pumped through the crude vs. reduced crude heat exchanger, passed through a water cooling-box and, at a temperature of 210°F., is fed to the desalting and deasphalting unit.

Intermediate reflux is pumped from the crude tower through the crude vs. intermediate reflux heat exchanger, through a water cooling-box and, at a temperature of 280°F., is returned to the side of the crude tower. The top reflux from the crude tower is pumped through the crude vs. top tray reflux heat exchanger, passes through a water cooling-box and, at a temperature of 140°F., is returned over the top tray thus controlling the tower top temperature. Ammonia as needed for neutralization is fed to the crude tower below the top tray.

The flow of the crude column's three side streams is as follows: Heavy gas oil at 640°F. goes to the bottom section of the stripper; light gas oil goes to the center section of the stripper at 555°F., and kerosine at 440°F. goes to the top section of the stripper. Strippings and steam from each section of the stripper are returned to the crude column.

TABLE 2

Typical crude oils used as refinery charge stocks

Crude	Woodlawn	Jennings	East Texas
Barrels in overall blend	4	2	12
Per cent in blend	16.66	8.33	66.7
Crude oil inspections			
Gravity—°A.P.I.	38.6	37.8	38.8
A.S.T.M. distillation			
I.B.P.—°F.	159	150	110
5 per cent	247	275	167
10 per cent	284	333	213
20 per cent	367	413	277
30 per cent	433	466	358
40 per cent	487	500	459
50 per cent	527	534	548
60 per cent	564	567	635
70 per cent	600	610	706
80 per cent	678	684	...
Per cent at 400°F.	25	18	35
Per cent at 650°F.	77	75	63
Sulphur, weight per cent	0.10	0.11	0.27
Conradson carbon weight per cent	0.23	1.86	1.85
A.S.T.M. (max.)—°F.	50	25	55
Viscosity—S.U.S.:			
at 77°F.	39	43	56
at 100°F.	36	38	43

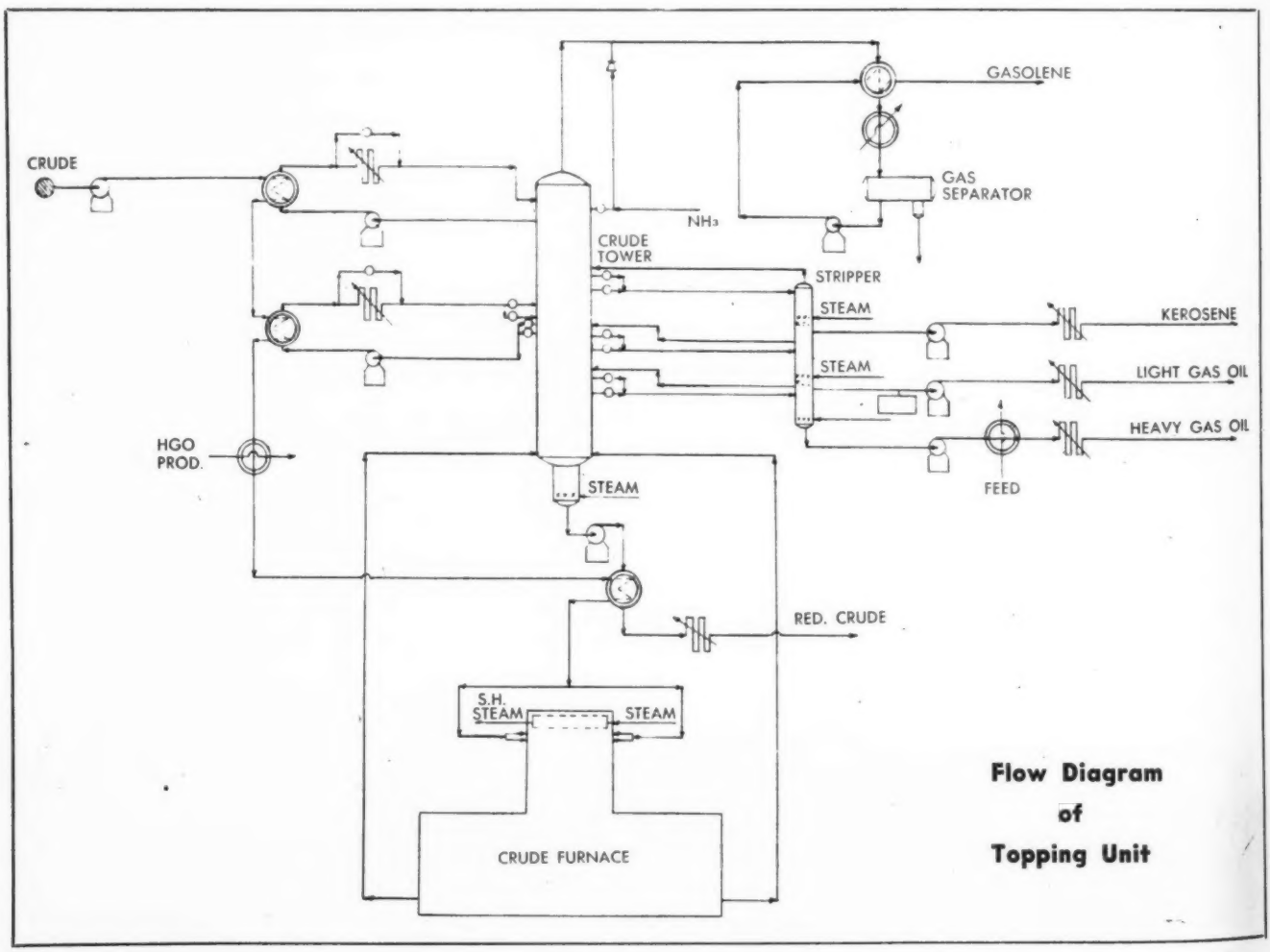
Stripped heavy gas oil leaves the bottom of the stripper, is pumped through the heavy gas oil vs. feed heat exchanger, passes through a water cooling-box and, at a temperature of 150°F. this fraction, boiling from 620°F. up to bottoms is charged to the refinery's "B" catalytic cracking unit charge tanks where it is blended with deasphalted gas oil to make up charge for that unit.

Stripped light gas oil leaves the bottom of the stripper's center section, is pumped through a water cooling-box and, at a temperature of 118°F. as a 520°F.-640°F. boiling range product, it is fed to the refinery's "A" catalytic cracking unit charge tanks and blended with kerosine to make "A" unit charge stock.

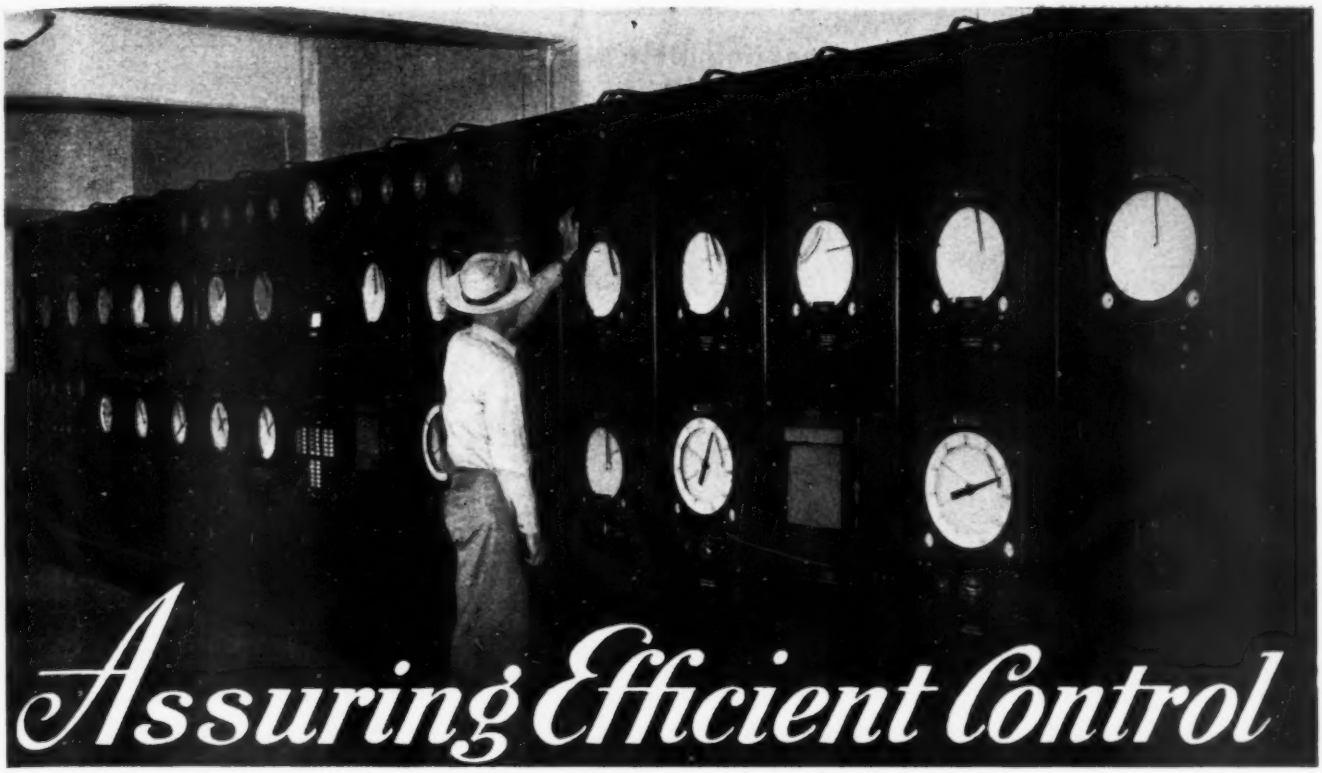
Stripped kerosine leaves the bottom of the stripper, is pumped through a water cooling-box and, at a temperature of 92°F. as a 360°F.-520°F. boiling range product, part goes to the treating plant for finishing and sales and part goes to the "A" catalytic cracking unit as feed. Table 3 details the inspections of feed and products.

Straight-Run Fractionating Unit

The principal components of the straight-run fractionation unit are: A reboiler furnace and the prefractionator, depropanizer, debutanizer, and deisopentanizer towers.



Flow Diagram of Topping Unit



Assuring Efficient Control

AT CITIES SERVICE REFINERY, Lake Charles, La.

DESIGNED and constructed by the M. W. Kellogg Co., New York, N. Y., this refinery is not only the world's first completely new, wholly integrated aviation fuel refinery and butadiene plant, but is one of the largest single refinery construction jobs in the history of the oil industry.

The Cities Service Refining Corporation plant at Lake Charles incorporates the latest technical developments including fluid type catalytic cracking, sulphuric acid alkylation, butane isomerization, crude distillation, and propane desalting and deasphalting units.

In the measurement and control of these processes Brown Air-O-Line ElectroniK Potentiometers are playing an important part in obtaining maximum yield at lowest cost. Advanced design and proven performance of the Brown Electronic "Continuous Balance" principle dictated the choice of these instruments.

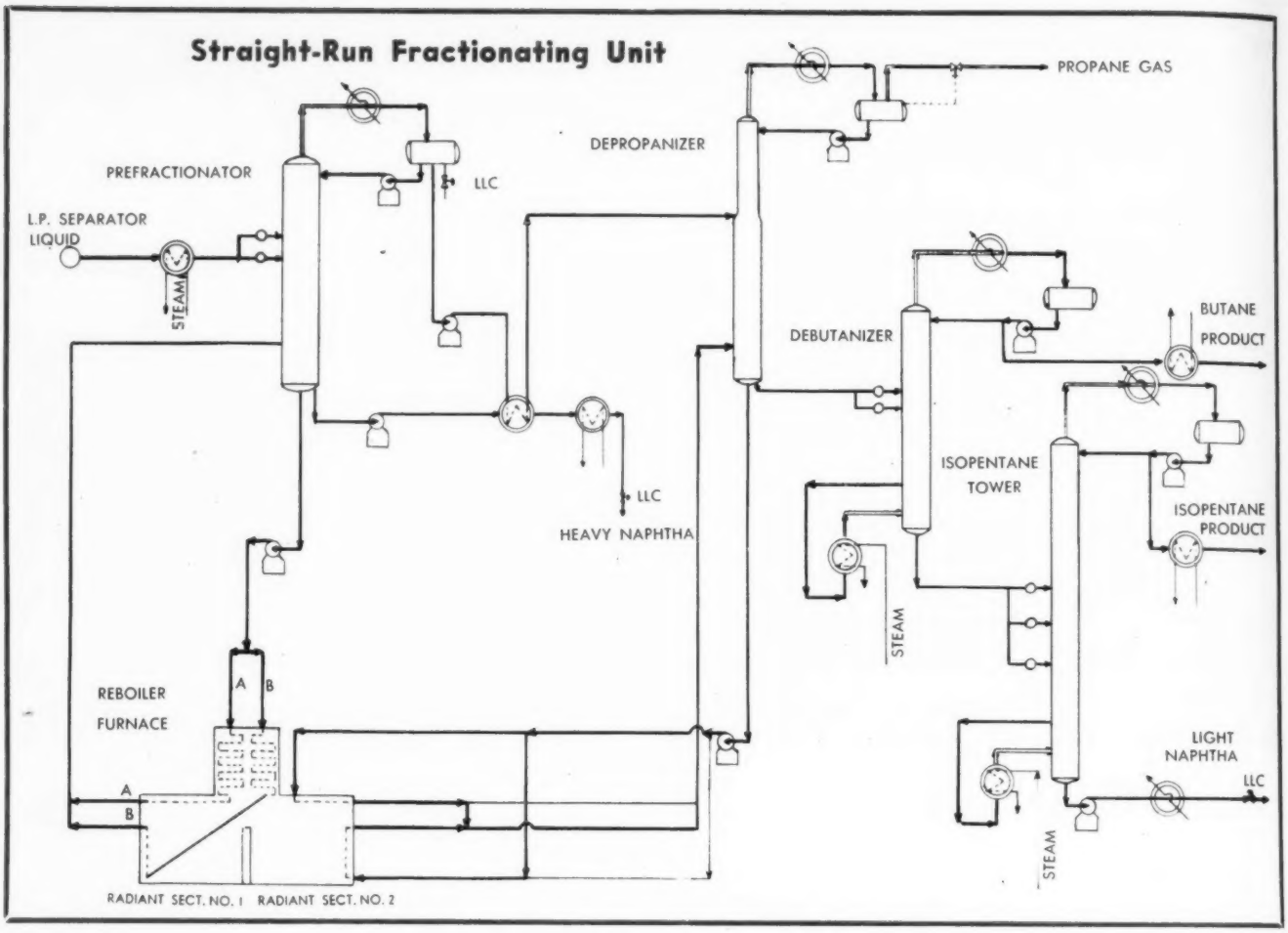
The Brown ElectroniK Potentiometer is the only type potentiometer instrument in which the air control flapper mechanism is instantly positioned in response to temperature changes. Its "Continuous Balance" measuring system makes it possible to take full advantage of thermocouple responsiveness. Positive control action is assured by the well-known, dependable Brown Air-O-Line control unit, thousands of which are in service throughout industry.

In addition to the Brown ElectroniK Potentiometer—Brown Flow and Liquid Level, Thermometers and Pressure Controllers are also included on the above panel board.

All of these instruments make possible the ideal synchronization of measurement and control of temperatures, pressures, flows, liquid levels. Here is another instance where Brown engineering and Instrumentation have kept pace with progress in the advanced technique of refinery processes which are now contributing to America's gasoline and synthetic rubber output.

To simplify your process control problem, call in a Brown engineer. Write THE BROWN INSTRUMENT COMPANY, 4475 Wayne Avenue, Philadelphia 44, Pennsylvania, a division of Minneapolis-Honeywell Regulator Company, Minneapolis, Minnesota. Offices in all principal cities. 119 Peter Street, Toronto, Canada—Wadsworth Road, Perivale, Middlesex, England — Nybrokajen 7, Stockholm, Sweden.

BROWN ElectroniK POTENTIOMETERS



The unit is charged with the 360°F. end point gasoline overhead from the topping unit in addition to natural gasoline.

Charge to the unit passes through a tubular steam preheater containing 782 tubes, ¾ in. diam. by 16 ft. long. The preheater is designed for a duty of 28,500,000 B.t.u. per hr. and the mean temperature difference is 112°F.

At a temperature of 266°F., the charge is fed to the prefractionator. This column is 81 ft. by 13 ft. 6 in. I. D. It contains 30 trays on 24-in. centers. The column is designed for operation at a pressure of 65 lb. per sq. in. gauge. The bottom temperature is 398°F. and the top temperature is 267°F. It is equipped with an overhead condenser and a liquid level-controlled reflux drum.

The overhead from the prefractionator is light naphtha, which is passed through the overhead condenser and, at a pressure of 35 lb. per sq. in. gauge, goes to the reflux drum. Reflux is off the bottom of the drum and over the top tray of the prefractionator.

The light naphtha from the bottom of the drum is fed to the depropanizer after passing through a tubular heat exchanger where it is preheated by exchange against the prefractionator bottoms stream. This exchanger is designed for a duty of 9,000,000 B.t.u. per hr. It contains 464 steel tubes, ¾ in.

TABLE 3

Inspections of feed and products (design basis)

A.S.T.M. distillation

	Crude	Gasoline	Kerosine	Light gas oil	Heavy gas oil	Reduced crude
Sample						
Time taken						
Gravity, °A.P.I.	36.1	55.0	41.2	35.2	28.2	21.2
I.B.P.	180	150	393	518	612	
5 per cent	344	191	413	546	684	
10 per cent	357	212	417	552	691	
20 per cent	400	232	422	556	702	
30 per cent	461	242	430	566	707	
40 per cent	511	257	438	571	712	
50 per cent	560	274	446	579	717	
60 per cent	608	288	454	588	724	
70 per cent	668	299	466	597	730	
80 per cent	710	312	476	609	734	
90 per cent	..	324	493	626	750	
95 per cent	..	335	508	639	..	
E.P.	..	345	522	655	..	
Per cent recovery	..	98.5	98.0	98.0	..	..
R.V.P.	..	3.0	..	..	..	..
Octane No.	..	53.6	..	..	..	..
Color	..	..	..	..	..	..
Viscosity, S.U. S. at 100°F	42.5	..	..	43.4	157	..
Viscosity, S.U. S. at 210°F	..	..	..	..	..	106.4
Flash	..	..	174	265	330	..
Conradson carbon	..	..	..	..	0.11	4.9
Sulphur	0.14	0.043	0.053	0.12	0.18	0.36
Salt, weight per cent	..	..	..	..	..	0.19
Pour point	35	..	−35	25	90	90
Aniline point	..	117	157	179	204	..

Yields

Crude used	South Louisiana, vol. per cent
Crude	100
Gasoline	26.0
Kerosine	26.0
Light gas oil	17.7
Heavy gas oil	15.3
Red. crude	15.0

The Beckman Infrared Spectrophotometer in use at Cities Service laboratories.

NEW CITIES SERVICE PLANT CONTROLS REFINERY PROCESSES WITH THE BECKMAN INFRARED SPECTROPHOTOMETER

THE BECKMAN Infrared Spectrophotometer—the most advanced instrument available for hydrocarbon gas analysis and control—is used to control the refining processes at Cities Service Corporation's new aviation gasoline and butadiene plant at Lake Charles, La.

This instrument permits analyses of even complex hydrocarbon mixtures to be made in only a few minutes, compared with many hours necessary by other methods. It furnishes the important operating data so essential for optimum performance in today's highly technical refinery operations. And yet the instrument is designed for fast, accurate routine operation, and gas analyses may be made by relatively unskilled operators.

The Beckman Infrared Spectrophotometer—a vital factor in today's war-paced aviation gasoline and synthetic rubber processes—has been in use since the very inception of the war program, and has established a place in the forefront of modern refinery control methods. And the extensive background gained through these years of pioneer refinery applications is the groundwork for even greater developments in this field by the Beckman research staff.

The Beckman Infrared Spectrophotometer has been thoroughly field proven under widely varying operating and climatic conditions, and has been adopted as the standard control equipment by leading oil companies. It not only is essential to modern refinery methods and control, but opens up entirely new fields in hydrocarbon research and development. Send for full information on this outstanding Beckman instrument!

IMPORTANT FEATURES OF THE BECKMAN SPECTROPHOTOMETER

- *Analyzes hydrocarbon mixtures by measuring the absorption of infrared radiation at selected wave lengths. Each component in a mixture is unerringly identified and its concentration accurately determined.*
- *Instrument is easily pre-set for as many as 18 wavelength positions, corresponding to hydrocarbons of specific interest, and needs only infrequent calibration checks.*
- *In routine operations, selected positions are instantly and precisely reproduced by a single indexing stop. No dials to read or adjustments to make.*
- *Highly accurate, showing an overall accuracy of ± ½ of 1% of the total sample during two years of tests involving more than 5500 analyses.*
- *Operation requires minimum calculation. Total time—including preparing samples, operating instrument, periodically checking method, making out reports and calculating results —averages* less than 20 minutes.

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STRUMENTS CONTROL MODERN INDUSTRIES

diam. by 16 ft. long. The mean temperature difference is 100°F.

Bottoms from the prefractionator are heavy naphtha, which is charged to the thermal reformer after passing through the prefractionator overhead vs. bottoms exchanger mentioned above and through a product cooler where the heat is exchanged against water, the product emerging at atmospheric temperature.

The prefractionator bottom temperature is maintained by recycling some of the bottoms through a gas-fired reboiler furnace, which also supplies reboiler duty for the depropanizer. This furnace is designed for a duty of 47,750,000 B.t.u. per hr. The normal heat liberated is 67,000,000 B.t.u. per hr. and the overall efficiency is 71.36 per cent. The total normal fuel fired is 3,260 lb. per hr. of gas of 20,560 B.t.u. per lb. lower heating value.

The furnace contains two radiant sections. The total heating surface is 6423 sq. ft. There are 70 floor burners. The temperature of flue gas leaving the furnace is 900°F. and the flue gas has 40 per cent excess air.

The depropanizer is 95 ft. high. The bottom diameter is 8 ft. tapering to 6 ft. 6 in. The bottom section contains 14 trays on 30-in. spacing and the top section contains 16 trays on 24-in. centers. The column's design pressure is 330 lb. per sq. in. gauge. The bottom temperature is 375°F. and the top temperature is 140°F.-150°F. It is equipped with an overhead condenser and a pressure-controlled reflux drum.

A feature of this column is its extremely close separation. Its charge is the total 225°F. end point light naphtha from the prefractionator. The column's overhead is propane gas, which passes through the overhead condenser to the reflux drum. Liquid propane is pumped from the bottom of the drum and, as reflux, is returned to the column over the top tray. The propane gas as overhead from the drum, goes to the plant fuel line.

The bottoms product consisting of C_4 through 225°F. end point fractions is charged directly to the debutanizer. Depropanizer reboiler duty is supplied by the reboiler furnace serving the prefractionator. Bottoms from the depropanizer are recycled through the furnace.

The debutanizer is 77 ft. 6 in. by 10 ft. 6 in. I. D. It contains 30 trays on 24-in. spacing. It is equipped with an overhead condenser, a reflux drum, and a high-pressure steam reboiler. Its design operating pressure is 100 lb. per sq. in. gauge. The bottom temperature is 280°F.-290°F. and the top temperature is 130°F.-140°F.

The overhead is butanes (iso and normal) which go to storage for charge as alkylation unit feed. This overhead passes through the condenser and into the reflux drum. Reflux from the bottom of the drum is back over the top tray. Normal butane and isobutane are withdrawn from the reflux line, passed through a product cooler and sent to storage.

Bottoms from the debutanizer is a C_5 up to 225°F. end point fraction, which is charged to the deisopentanizer. The deisopentanizer is 116 ft. by 10 ft. I. D. It contains 50 trays on 24-in. spacing. Its design pressure is 50 lb. per sq. in. gauge. The bottom temperature is 244°F. and the top temperature is 159°F. It is equipped with an overhead condenser, a reflux drum, and a high-pressure steam reboiler.

This tower splits between iso and n-pentane, producing approximately 95 per cent purity isopentane as overhead and a normal pentane to 225°F. end point fraction as bottoms.

The overhead passes through the overhead condenser to the reflux drum. Reflux is back over the top tray. The isopentane from the bottom of the reflux drum passes through a products cooler to intermediate products storage.

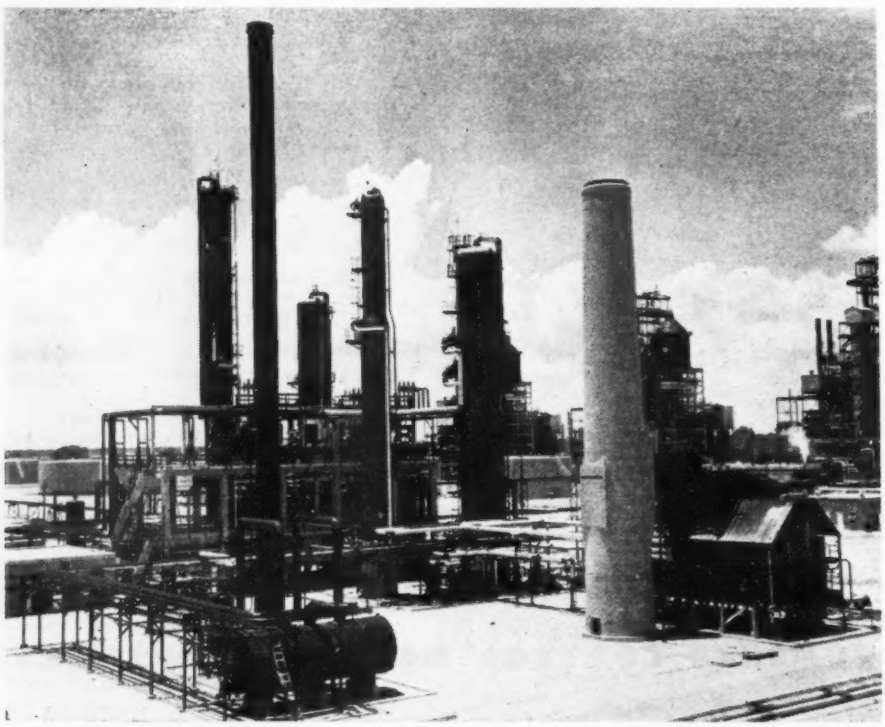
Bottoms from the tower, C_5 up to 225°F. end point fractions, pass through a product cooler and thence to storage for aviation blending, for secondary aviation fuel or for motor gasoline. Table 4 details the unit's product inspections.

TABLE 4

Straight run fractionation inspections

A.S.T.M. distillation			Podbielniak distillation				
	Prefract. bottoms	Light naphtha		Prefract. casinghead	Deprop. gas	Butane	Isopentane
A.P.I.	53.0	74.8					
I.B.P.	216	119	C_3H_8		9.1		
5 per cent	...	...	C_3H_6		78.4		
10 per cent	228	129	I-C_4H_{10}	10.4	3.1	26.6	
30 per cent	241	134	N-C_4H_{10}		9.4	72.6	0.2
50 per cent	255	140	I-C_5H_{12}	16.6			96.9
70 per cent	278	148	N-C_5H_{12}	9.6			1.3
90 per cent	317	157	C_6H_{14}+	63.4			
95 per cent	...	...	Unsats.			0.8	
E.P.	367	200					
R.V.P.	1.1	7.1					
Color	28	30					

Straight-run fractionation area looking northwest



Desalting and Deasphalting Unit

This unit has two functions. The first is to go down to a low percentage of bottoms on crude to obtain the maximum charge for the catalytic cracking units. The second is to remove salt from crude, which at present is thought to be deleterious to the catalyst. The process separates the hydrocarbons by types rather than by boiling range thus giving the least refractory hydrocarbons for catalytic cracking feed.

The unit is charged by reduced crude

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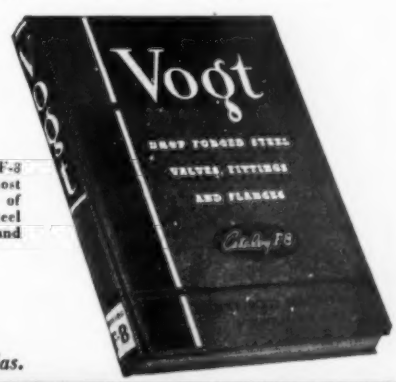

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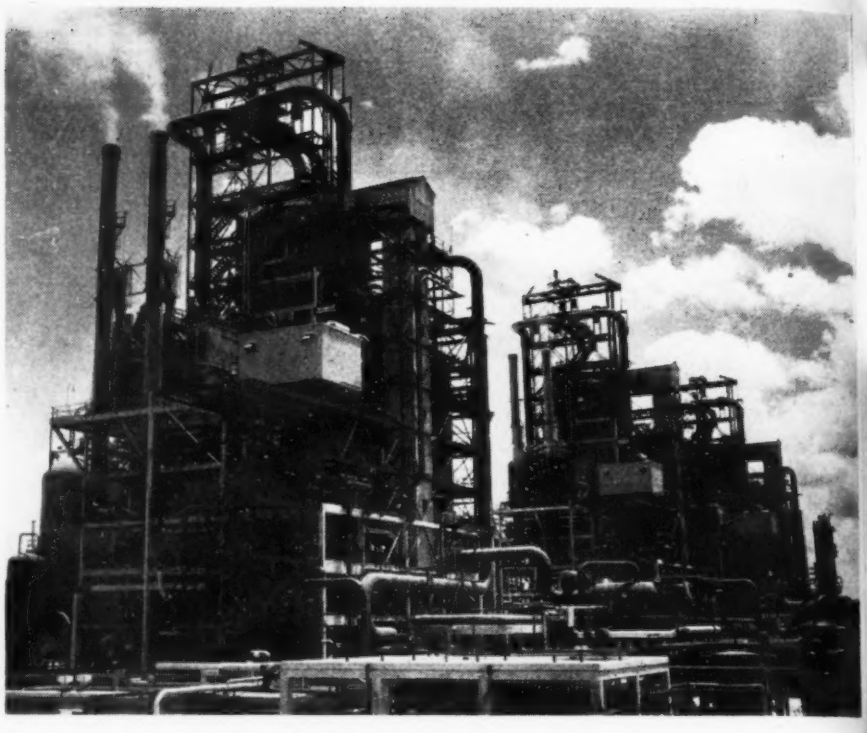
from the topping units, which is contacted by propane from the "A" alkylation unit, split in two streams and passes through steam preheaters to settling drums in which the mixture separates into two liquid phases; the asphaltic phase settling to the bottom of the drum and the raffinate floating on top.

Bottoms from the settlers go to the furnace and pass through in two parallel streams and then, in a common line, go to a high-pressure flash drum. Flashed-off propane vapor is returned to the propane storage tank. The bottom product from the flash drum is asphalt, which goes to a steam stripper where all traces of propane are removed. Bottom product from the steam stripper is finished asphalt. Facilities are available for cutting asphalt with gas oil at the unit.

Raffinate and propane from the top of the settling tanks go to a low-pressure steam vaporizer-drum in two streams. Propane vapor as overhead from this drum is returned to propane storage. Water settles to the bottom of the vaporizer-drum and is withdrawn.

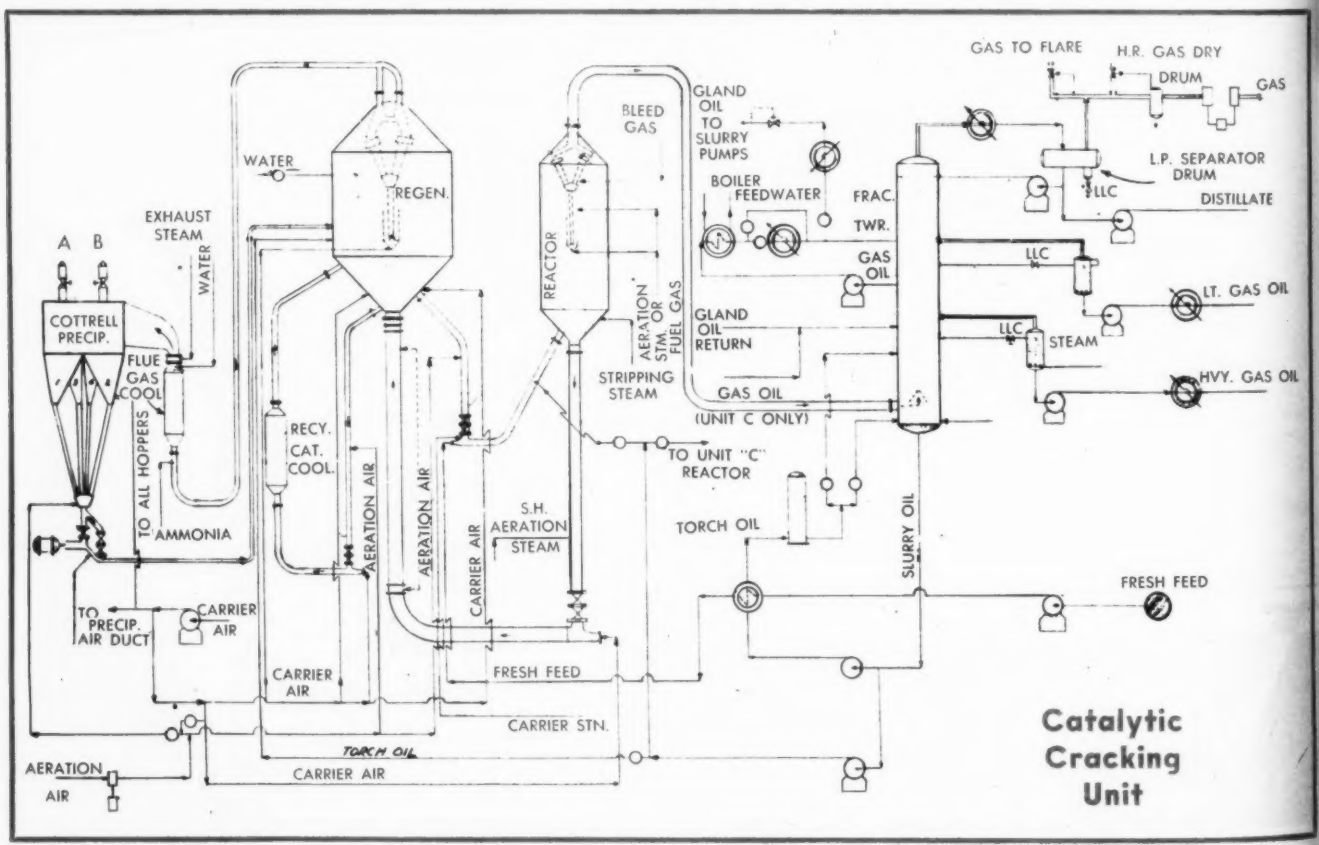
The oil then goes to a high-pressure steam vaporizer-drum where additional propane vapor is removed overhead and returned to storage, the oil from the bottom going to a steam stripper, which removes final traces of propane. Propane-vapor overhead from this stripper joins the propane-vapor line from the first mentioned steam stripper, goes to a water wash-drum, then to a compressor dry-drum, and to a 2-stage compressor where it is compressed and cooled and returned to the propane storage tank. The deasphalted and desalted product is sent to the "B" catalytic cracker feed tanks and blended with heavy gas oil from the crude fractionation units.



Catalytic cracking units "A," "B," and "C" looking east

Catalytic Cracking

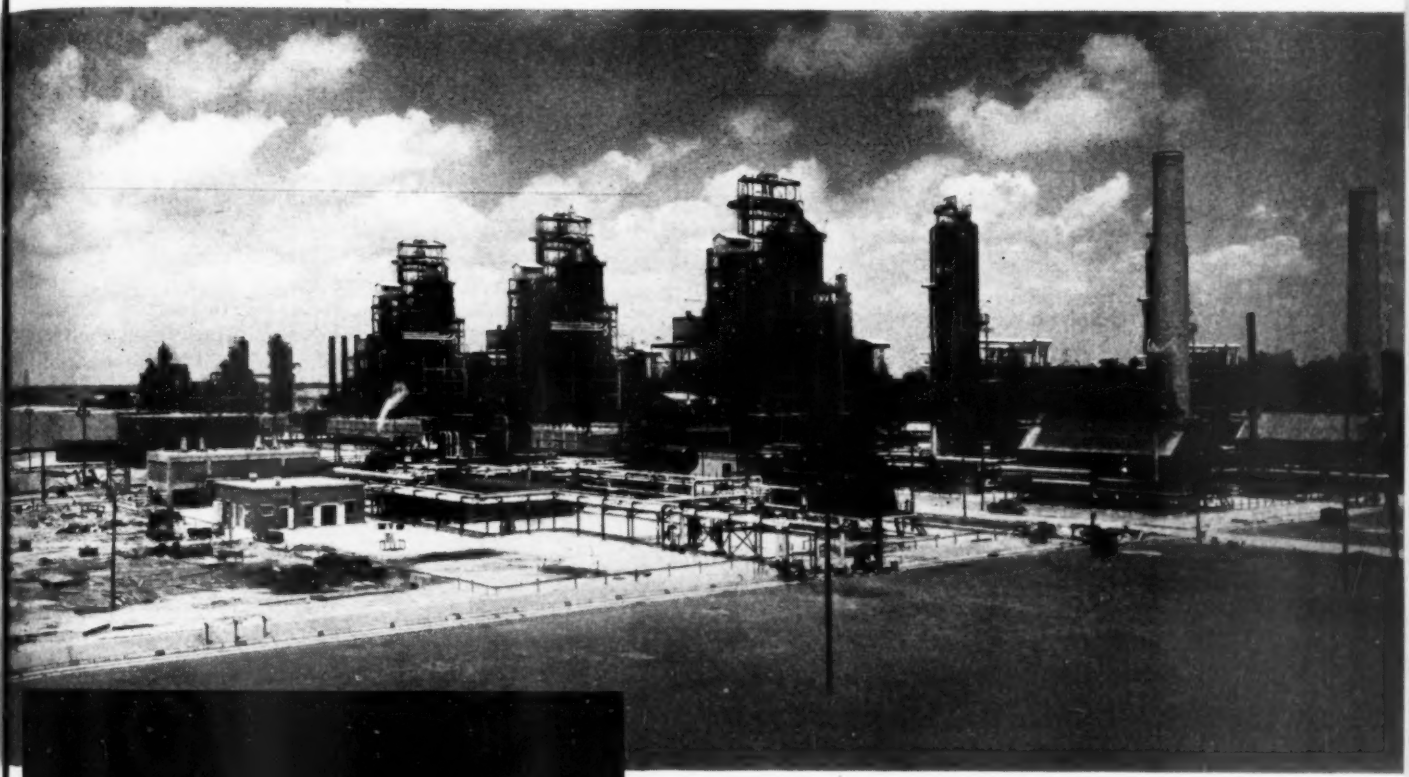
This section of the refinery is composed of three fluid catalytic cracking units designated "A," "B," and "C." The principal components of each unit are a reactor, regenerator, precipitator,

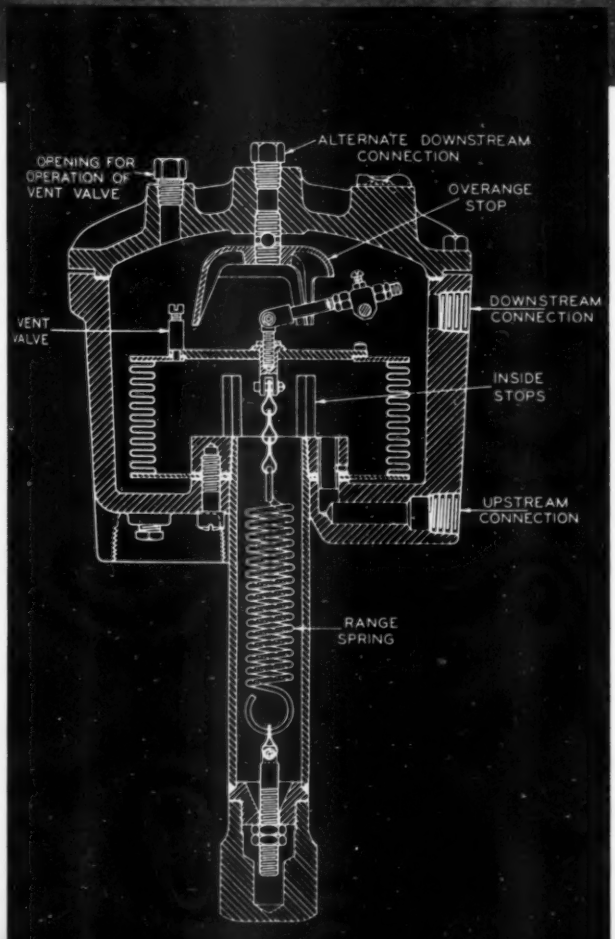


Accurate orifice measurement

WITHOUT MERCURY

at Lake Charles





FOR THIS outstandingly advanced high octane fuel plant, important applications were found for AMERICAN bellows-actuated differential gages. The advantages are many and specific.

Aside from eliminating the mercury problem, these instruments provide a degree of versatility that is notable. By simple change of the tension spring, the range of the instrument can be converted from 20" to 200".

In the bellows-actuated operation, provision is made so that a reverse flow condition cannot collapse the bellows. Expansion of the bellows is limited by stops.

The instrument is especially rugged, and features the same simplicity of design which is basic in AMERICAN orifice meter and controller operation.

With the serious shortage of maintenance men this simplicity and ease of inspection and adjustment assume dominant importance.

AMERICAN METER COMPANY

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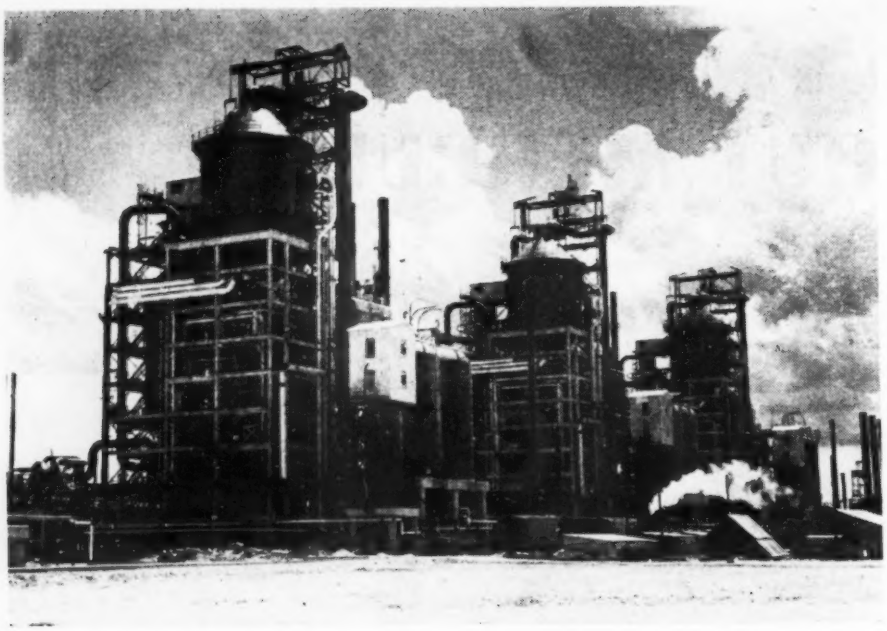


Catalytic cracking units looking southwest

and a bubble tower. The units employ a synthetic powder catalyst, the principle being that a powder, when properly aerated, can be controlled as though it were a fluid.

The function of units "A" and "B" is to produce gasoline re-treat feed for the "C" unit. In effect, the "C" unit is a second-pass unit re-treating its feed for aviation base stock. All three units produce C_{48} for butadiene and alkylate. All three units also produce furnace oil and heavy gas oil for vis-breaker feed or fuel oil blending.

Feed to the "A" unit is kerosine and light gas oil from the topping unit. Heavy gas oil from the topping unit and raffinate from the deasphalting unit form the "B" unit feed. The feed to the "C" unit is the 150°F.-475°F. gasoline fraction from the "A" and "B" units and the 350°F.-420°F. fractions from the thermal reforming unit.

Oil Cycle

There are two feed tanks serving each unit. Fresh feed at atmospheric temperature passes through a tubular exchanger for preheating to a temperature of 200°F.-400°F. by exchanging against the bubble tower bottoms circulating steam. The variance in the preheat temperature range affects the catalyst-oil ratio as will later appear. The feed is injected into a stream of hot fluid catalyst from the regenerator. The temperature of the hot catalyst is 1000°F.-1150°F.

The ratio of oil to catalyst is so controlled that the oil will be vaporized and receive its heat of reaction. Depending on the type of operation, the character of the feed, and the products desired, the reaction temperature can be held at any level between 700°F. and 1000°F.

After the reaction takes place, the vapors pass overhead to the unit's fractionating tower where the vapors are desuperheated and fractionated to pro-

Refinery column design data

Unit	Vessel	Height	Inside diam.	Design temp. in °F.		Design pressure *	Piping sizes			Trays		Equipment and remarks
				Top	Bottom		Inlet, in.	Overhead, in.	Bottom, in.	No.	Spacing, in.	
Topping	Prefractionator	90 ft.	19 ft.	260	710	35	16‡	24	..	30	30	
	Bottom strip. section	14 ft.-6 in.	9 ft.	..	710	35	..	..	10	3	30	
	Side stream steam strip	48 ft.	6 ft.			35	..	..	..	12	30	3-section stripper.
	Bottom	..	..	580	580	..	8	12	8	4	24	
	Center	..	..	535	535	..	8	12	6	4	24	
	Top	..	..	425	425	..	8	12	8	4	24	
Straight run fractionation	Prefractionator	81 ft.	13 ft.-6 in.	267	398	65	20	20	8	30	24	O.H. cond. L-L controlled reflux drum.
	Depropanizer	95 ft.	8-6 ft.-6 in.	140-150	375	330	..	..	..	30	..	2-section col. with O.H.
	Bottom section	..	..	..	..	..	10	..	8	14	30	cond., reflux drum and
	Top section	..	..	..	..	..	8	8	..	16	24	h.p. steam reboiler.
	Debutanizer	77 ft.-6 in.	10 ft.-6 in.	130-140	280-290	100	10	16	10	30	24	O.H. cond., reflux drum h.p. steam reboiler.
	Deisopentanizer	116 ft.	10 ft.	150	244	50	10	16	10	50	24	Same as debut.
Catalytic cracking	Fractionator	76 ft.	16 ft.	240	700	30	37	20◇	8•	18	30	O.H. cond. l.p. separator drum.
	No. 1 side strip	25 ft.-6 in.	6 ft.-6 in.	650	650	30	6	10	6	6	30	
	No. 2 side strip	18 ft.	5 ft.	605	605	30	4	10	4	6	24	
Thermal reforming	Combination	100 ft.	12 ft.	400	700	125	..	..	..	34	30	O.H. cond., top reflux
	Evaporator section	..	..	..	..	..	8	..	6	4	30	cooler, gas sep. drum.
	Bubble tower section	..	..	..	..	..	10	12	12	30	30	
	Side stream steam strip	22 ft.-6 in.	3 ft.	300	400	125	6	6	3	8	24	Accumulator drum.
	Absorber	73 ft.-6 in.	8 ft.	110	120	125	10	8	12	30	24	
	Debutanizer	73 ft.	6 ft.	145	440	290	8‡	10	6	24	30	O.H. cond., reflux drum, h.p. steam reboiler.
Gas recovery	Absorber	77 ft.	10 ft.-6 in.	84	108	220	20	12	14	30	24	
	Lean oil still	78 ft.	12 ft.	260	540	90	20	20	14	18	24	O.H. cond., reflux drum, gas-fired reboiler
	Splitter	88 ft.	12 ft.-6 in.	165	375	85	16	30	6	30	24	O.H. water-cooled cond., reflux drum, gas-fired preheater and reboiler.
	Depropanizer	89 ft.-11 in.	9 ft.-6 in.	125	270	314	8	12	8	30	30	O.H. reflux cond., reflux drum, h.p. steam reboiler.
	Debutanizer	78 ft.	9 ft.	142	245	115	12	14	6	30	24	Same as depropanizer.
	Re-treat fractionator	63 ft.	7 ft.-6 in.	140	350	95	8	10	6	22	24	O.H. cond., reflux drum with water tap.
Alkylation	Deisobutanizer	114 ft.-6 in.	13 ft.-6 in.	137	200	105	8	16◇	6	50	24	O.H. total water cond., reflux drum, h.p. steam reboiler.
	Depropanizer	85 ft.	6 ft.	115	200	250	4	6	8	28	30	Same as deisobutanizer.
	Debutanizer	67 ft.	7 ft.	132	320	100	4	10	4	24	30	Same as deisobutanizer.
	Re-run	49 ft.	5 ft.-6 in.	215	365	36	..	..	..	16	..	Same as deisobutanizer.
	Bottom section	..	..	..	..	..	12	..	3	2	18	
	Top section	..	..	..	..	..	6	10	6	14	30	
Isomerization	HCl stripper	54 ft.-6 in.	4 ft.	165	245	385	3	4	4	20	24	O.H. cond., reflux drum, h.p. steam reboiler.

*Design pressure in lb. per sq. in. gauge.
‡There are 2 inlet lines.
◇There are 2 overhead lines.
•There are 3 bottoms lines.
All columns equipped with rectangular cast-iron bubble caps.

duce distillate, light cycle gas oil, and heavy cycle gas oil.

The fractionator is 76 ft. by 16 ft. I. D. It contains 18 trays on 30-in. centers plus 7 disk and doughnut-type baffles in the bottom scrubber section. The design pressure is 30 lb. per sq. in. gauge. Design bottom temperature is 700°F. The design top temperature is 240°F. The vessel is equipped with an overhead condenser and low-pressure separator drum and two side stream steam strippers.

The overhead is distillate plus gas, which passes through the overhead condenser to the low-pressure separator drum. The overhead gas from the drum is compressed in four gas engine-driven 600-hp. compressors and goes to the gas recovery and fractionation unit. Distillate, as bottoms from the drum, is in part returned as reflux over the top tray of the tower; the balance goes to the gas recovery and fractionation unit.

The upper side stream draw-off, when re-treating, consist of heavy naphtha, or furnace oil when cracking. This passes through a side stream stripper and is pumped through a products cooler and goes to furnace oil product blending or motor gasoline blending.

The lower side stream draw-off is heavy gas oil when cracking or total gas oil when re-treating. This likewise passes through a side stream steam stripper, is pumped through a products cooler to storage.

In the operation, the end point of the overhead distillate may be varied from 300°F. to 500°F. with a corresponding variance in the side stream products.

Catalyst Cycle

After reaction, hot catalyst at a temperature of 700°F.-1000°F. is continuously withdrawn from the reactor and flows down a standpipe through a rate-controlling slide valve that is automatically controlled by the pressure drop across the reactor. Below the slide-valve, the catalyst is picked up by a moving stream of carrier air, which carries it up into the regenerator vessel where the air burns the carbon deposit from the catalyst. The catalyst then flows downward through standpipes and slide valves, controlled by the reactor temperature. Below the slide valves it again receives the fresh oil charge and is carried into the reactor.

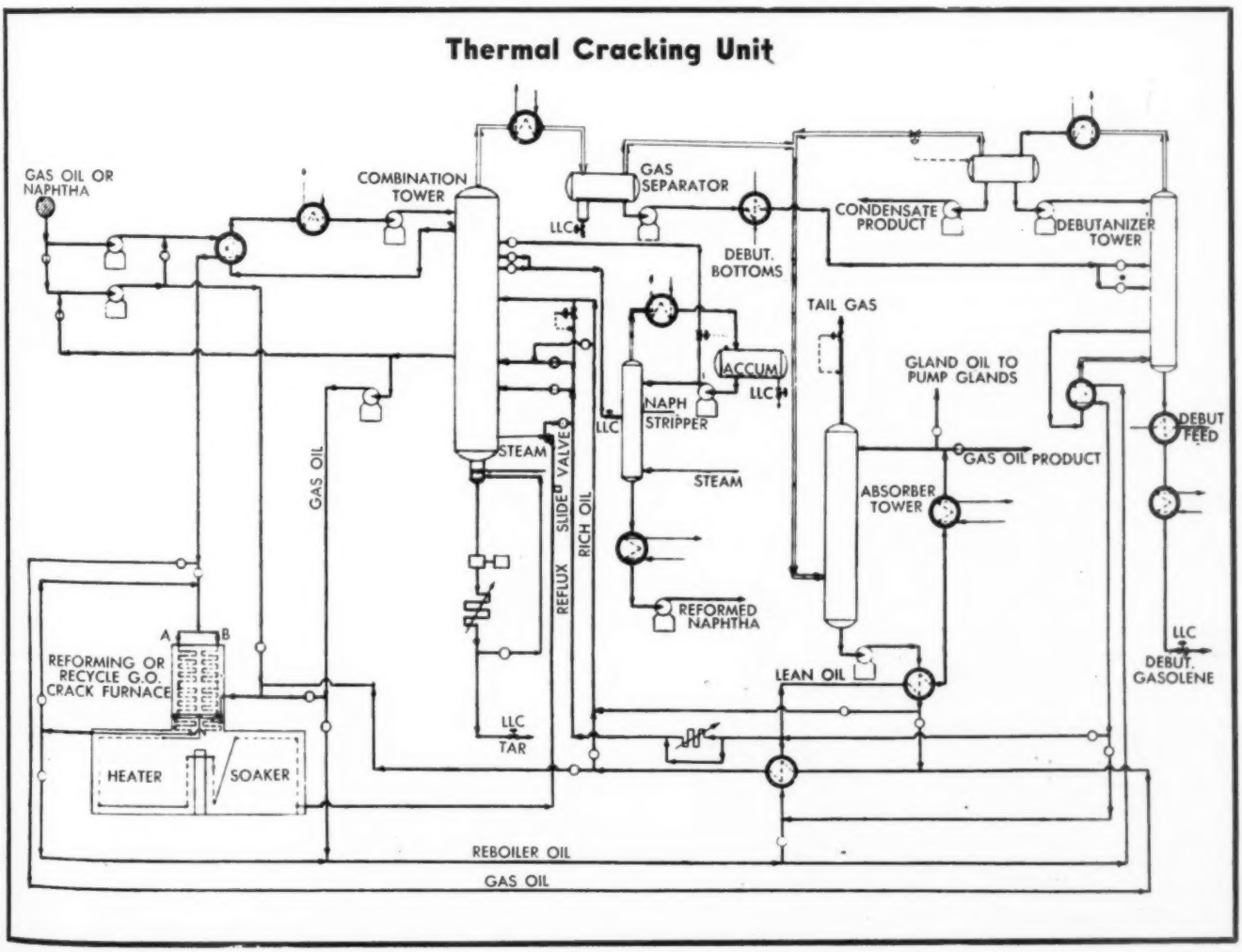
Excess heat, liberated in the regenerator over and above that required for oil vaporizing and cracking, is removed by circulating a stream of fluid catalyst through a waste heat boiler that generates high-pressure steam and the catalyst is returned to the regenerator.

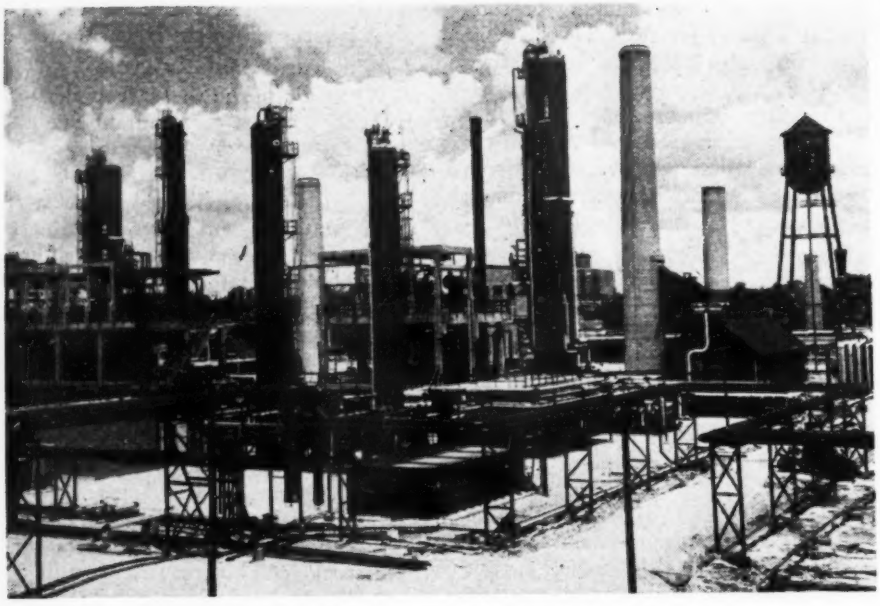
Air-Flue Gas Cycle

When air burns the carbon deposit from the catalyst the resultant flue gas flows through cyclone separators overhead from the regenerator. The flue gas is cooled and "conditioned" by water, steam and ammonia after which the conditioned flue gas passes through a Cottrell precipitator where any small amounts of entrained catalyst are removed electrically. The flue gas then passes off through the stack. The electrically precipitated catalyst fines are collected in hoppers below the precipitator and returned to the regenerator in an air stream.

The cracking and regeneration operations described occur continuously. Depending on the type of operation, feed stock, cracking severity required, etc., the space velocities may be varied over a considerable range of from less than 1.0 to approximately 12.0 as required. This is a weight-space velocity defined as weight of the oil fed per hour divided by the weight of the oil fed per hour divided by the weight of the catalyst hold-up in the reactor. The space rate is adjusted by raising or lowering the level of the "boiling fluid catalyst" in the reactor.

The other variable is the catalyst to





Thermal reforming unit looking northeast

oil ratio. This is defined as weight of the catalyst circulated per hour over the weight of the oil fed per hour. This ratio may be varied over a considerable range by changing the feed preheat temperature.

The catalyst-oil ratio may also be varied by raising or lowering the regenerator temperature. This is accomplished by increasing or decreasing the rate of catalyst circulation through the waste-heat boiler.

There are several operating advantages arising from the installation of three catalytic cracking units.

One of these advantages is that of maintaining the catalyst balance. Some catalyst passes through the cyclone separators and these catalyst particles are necessarily smaller than those remaining in the system. Therefore, transferring catalyst fines may unbalance the relative catalyst density in the various units. As another source of fine particle size catalyst is available from the Cottrell precipitator hoppers, means have been provided for the intertransfer of these catalyst fines.

Two additional advantages arise out of the last. The first is catalyst particle size may be controlled in any one unit to secure any degree of coarseness desired. This is accomplished by transferring the fines in carrier air from one unit to the other. This permits high densities to be obtained in the reactor and consequently higher cracking density.

The second is: Catalyst losses for all three units may be replaced at one unit thereby controlling the catalyst activity in the various units at as near the optimum level as possible for the operation being performed.

Steam

The waste heat boiler, the slurry oil boiler, and flue gas cooler generate high-pressure steam which is subsequently superheated in a small superheater furnace located within the unit to provide process, stripping, and aeration steam for the unit's requirements.

Thermal Reforming Unit

The principal components of this unit are a combination tower that has several interesting features, an absorber tower, a debutanizer tower, and a reforming or recycle gas oil cracking furnace.

The unit is charged by heavy naphtha from the refinery's straight-run fractionation unit. Its functions are to improve the octane number of the heavy naphtha and to produce butylenes for butadiene manufacture and for alkylation.

The heavy naphtha is charged into the unit at a temperature of 100°F. and at atmospheric pressure it passes through a tubular exchanger for exchange against reflux from the top of the combination tower. This exchanger is designed for a duty of 3,250,000 B.t.u. per hr. It contains 360 admiralty tubes, ¾ in. diam. by 16 ft. long. The mean temperature difference is 36°F.

From this exchanger, at a temperature of 330°F., the feed passes to the gas-fired naphtha reforming furnace. This furnace has a convection surface preheater, a radiant section heater, and a radiant section soaker. The furnace is designed for a duty of 139,060,000 B.t.u. per hr. The normal heat liberated is 199,600,000 B.t.u. per hr. The overall efficiency is 69.73 per cent. The total normal fuel fired is 9710 lb. per hr. of gas of 20,560 B.t.u. per lb. lower heating value. Flue gas leaves the furnace at 950°F. and contains 40 per cent excess air. There are 16,527 sq. ft. of heating surface. The furnace contains 180 tubes of various dimensions. The furnace operates at approximately 1050°F. and at a back-pressure of approximately 300 lb. per sq. in. gauge maintained by a slide valve on the combination tower.

The flow from the furnace is to the slide valve mentioned. In the slide valve, the reformed naphtha is quenched by cooled cycle gas oil and the quenched,

TABLE 5

Thermal reforming unit inspections

	A.S.T.M. inspections			Composition analyses	
	Fresh feed	Tar	Debut. gasoline	Dry gas	Cond. prod.
Gravity	52.2	15.0	49.6		
I.B.P.	200		119		
5 per cent	230		158		
10 per cent	241		182	H_2	..
20 per cent	259		216	C_1	..
30 per cent	271		236	C_2—	..
40 per cent	283		255	C_2+	..
50 per cent	297		270	C_3—	22.7
60 per cent	310		285	C_3+	23.7
70 per cent	329		305	C_4—	34.8
80 per cent	345		327	iC_4+	4.8
90 per cent	380		356	nC_4	14.0
95 per cent	400		376	C_5	..
98 per cent	..		390	C_6+	..
F.B.P.	418		400		
Recovery	99.0		99.0	Total	100.0
Residue	1.0		0.6	Mol. weight	53.3
R.V.P.	0.3		2.3		
Octane	45		70.0		
Color	28		..		
Aniline No.	130		82		

Yields

	Volume, per cent	
Fresh feed	100.0	
Reform. naphtha	10.0	350°-420°F.
Tar	5.0	
Condensables C_3 and C_4	15.4	
Debut. gasoline	60.0	C_5-350°F.

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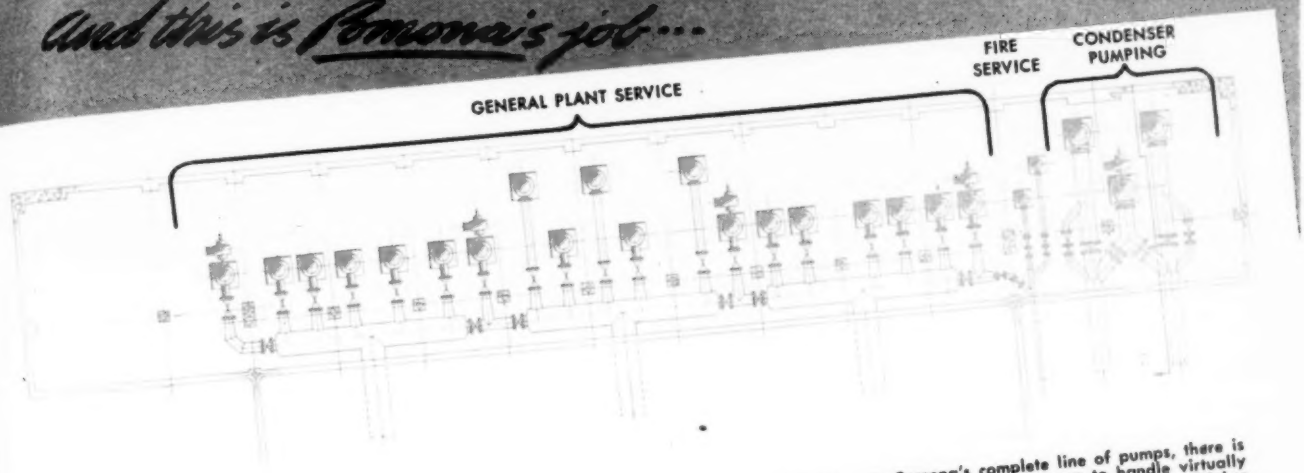
WORLD'S LARGEST VERTICAL PUMP STATIONS

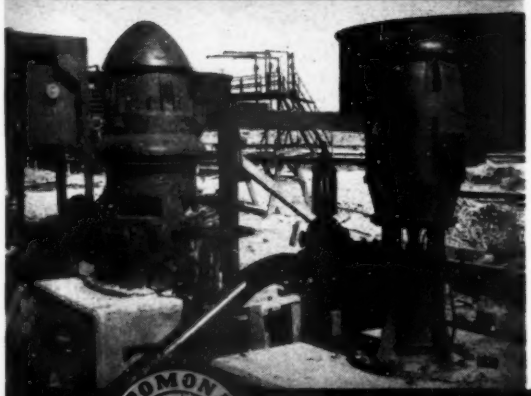
And this is Pomona's job...



PROBABLY THE LARGEST vertical pumping station in the world, this giant installation at Cities Service newly completed refinery embodies advanced features that simplify maintenance and assure the maximum in operating efficiency. This plant requires some 275,000 gallons of water per minute for operation and Pomona Pumps handle the condenser pumping, the fire water requirements and help supply raw water for general plant operations, as well as handling cooling tower pumping at another station in the large plant.

In Pomona's complete line of pumps, there is a size and type of pump to handle virtually every water moving requirement with higher efficiency, greater economy and maximum adaptability to plant requirements. Capacities from a few gpm to 300,000 gpm—and higher!

(Above) Small part of installation showing typical foundation and piping details. Note compactness of the pumps. *(Below)* Another part of pump station.



HOW CITIES SERVICE MADE IMPORTANT SAVINGS WITH POMONAS!

Besides being unusually efficient and trouble-free, Pomonas are also amazingly compact pumps. On Cities Service installation this meant important savings on foundations, pump house, construction costs, etc., as well as a simpler, more compact piping arrangement that further cut costs and maintenance to the minimum.

As indicated above, the main pumping installation consists of some twenty-four vertical pumps of various sizes...

- General water requirements are supplied by fifteen electrically driven vertical pumps, manifolded into three groups of five pumps each. And as standbys to these, four Pomona Verticals, each driven by a 450 horsepower horizontal turbine, are installed with right angle gear head drives.
- Three more Pomona Pumps—Niagara Mixflows—handle the condenser water service. Two are electric drive and the third—a standby unit—is a horizontal steam-turbine drive. Each of these pumps is rated 20,000 gpm at 43' head and a unique by-pass arrangement is incorporated which, by opening automatically when pumping pressures become excessive, protects motors against overload.
- Water for fire service is supplied by two more Pomona Turbine Pumps—both with vertical steam-turbine drives—and designed to deliver 1,000 gpm at 150 lbs. pressure.

In addition, at another pumping station six more Pomona vertical turbine pumps, each rated 9000 gpm at 150' head, handle the cooling tower pumping at the Butadiene Plant, while another electric-drive Pomona handles fire protection pumping at this plant.

This is another typical example of the ability of Pomona equipment to handle all types of pumping jobs in plant operations, large or small. Why not let our trained engineering staff consult with you on the best solution to YOUR particular problem? See your nearby Pomona dealer ... or write direct!

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reformed naphtha flashes into the evaporator section of the combination tower.

Combination Tower

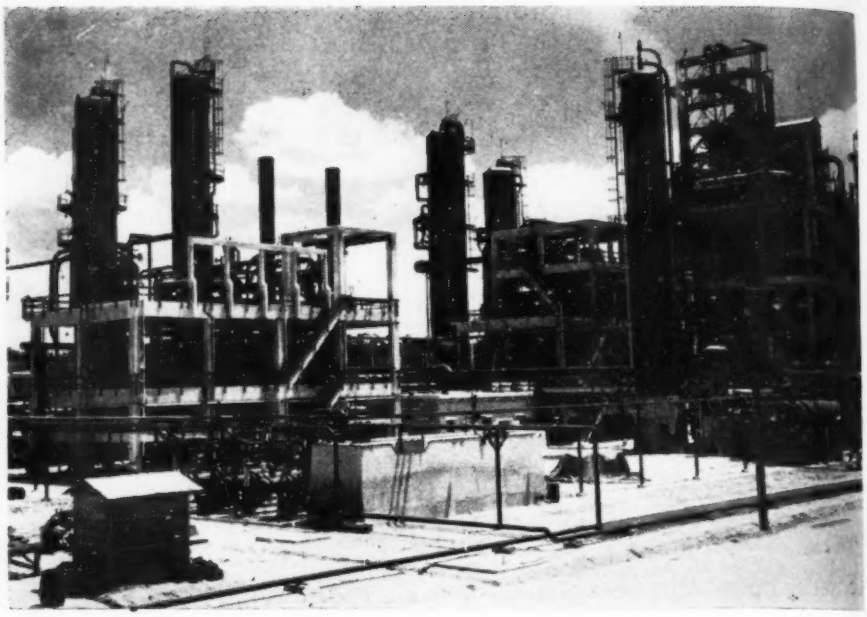
The combination tower is 100 ft. by 12 ft. I. D. The design pressure is 125 lb. per sq. in. gauge. The bottom temperature is 700°F. and the top temperature is 400°F. The tower is equipped with an overhead condenser, a top reflux cooler, a gas separator drum and a side stream steam stripper.

The bottom section of the tower is an evaporator. This contains baffles and four traps on 30-in. centers. The upper or bubble tower section contains draw-off baffles, draw-off pans, and 30 trays on 30-in. centers.

The flow of the combination tower is quite complex. It receives quenched, reformed naphtha in the bottom of the evaporating section. This section also receives some rich oil from the unit's absorber and the evaporator is refluxed by cycled gas oil.

The upper, or bubble tower section, receives the overhead from the evaporator, the major amount of rich oil from the absorber and the net overhead product of the side stream steam stripper.

The evaporator section cools the quenched reformed naphtha and fractionates from it a small amount of tar, which passes from the base of the tower to and through a tar cooler-box and thence to storage or to fuel oil blending.

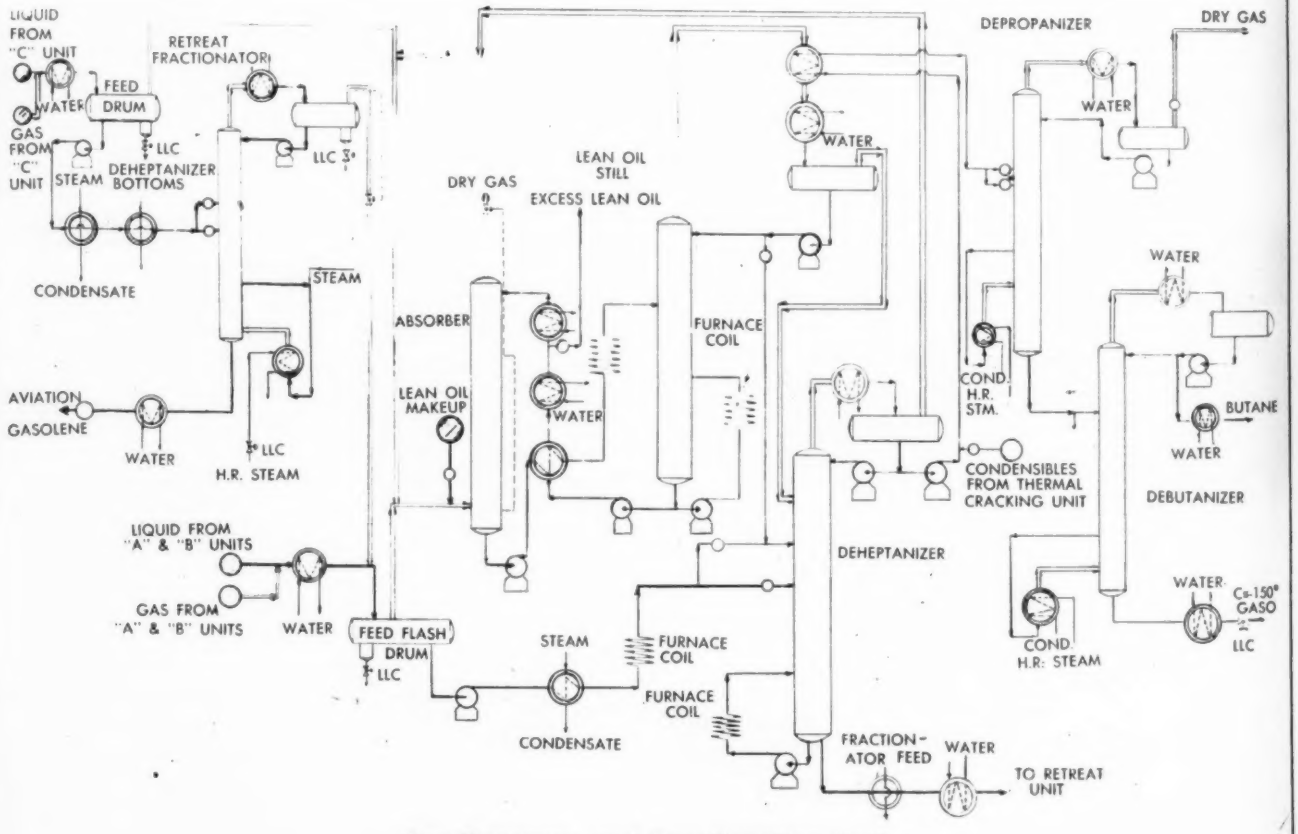


Catalyst fractionation area looking northwest

The evaporator overhead flows into the upper section. Circulating top tray reflux, which is first cooled by passing through the fresh feed heat exchanger and additionally cooled in a top reflux-cooler, serves to condense and fractionate out the quench and evaporator reflux. As much rich oil from the absorber as possible is fed to this section.

Quench, gas oil reflux, and lean oil are pumped from the bottom pan of the bubble tower section, heated in the furnace convection section and serves as a heating medium in the unit's debutanizer tower reboiler.

The stream is then additionally cool-



Gas Recovery and Fractionation Unit

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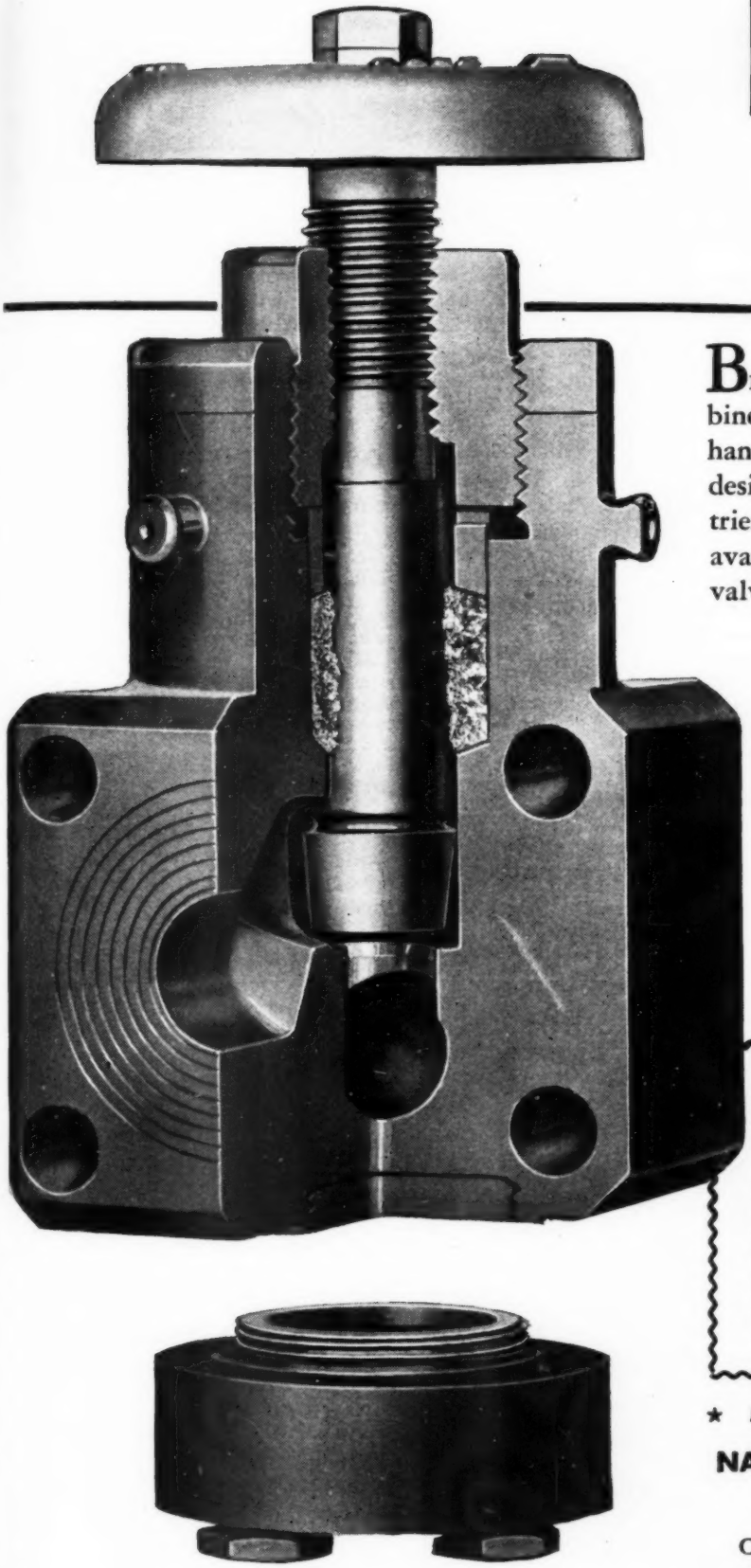

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ed by exchange against rich oil and, at this point, the gas oil reflux and quench leave the lean oil stream. The lean oil is still further cooled by a second exchange against rich oil, passes through a water cooler and thence to the top of the absorber tower. The gas oil reflux and quench, after leaving the lean oil, are further cooled in a cycle gas oil cooler before again being used at the evaporator and slide valve respectively.

A side stream of heavy naphtha is taken from the bubble tower section of the combination tower to the naphtha stripper. This tower is 22 ft. 6 in. by 3 ft. I. D. It contains 8 trays on 24-in. spacing. It is equipped with an accumulator drum. The tower is designed for a pressure of 125 lb. per sq. in. gauge. Its bottom temperature is 400°F. and its top temperature is 300°F.

The reformed naphtha is stripped by high-pressure steam and, as bottoms from the stripper, passes through a cooler box and is pumped to storage. This naphtha fraction boiling from 350°F.-420°F. is used as feed to the "C" catalytic cracking unit for re-treating to aviation base stock.

Overhead strippings from the stripper pass through a water cooler to an accumulator from which reflux goes to the stripper's top tray and the net overhead product is returned to the combination tower's top section.

The overhead vapors from the bubble tower section of the combination tower are 350°F. end point and lighter fractions, which pass through the overhead condenser to a high-pressure gas separator. The overhead from the separator goes to the absorber tower. The bottoms go through a preheater to the unit's debutanizer.

The overhead from the debutanizer passes through a cooler to a reflux drum and the overhead from this drum goes to the absorber. A C_3-C_4 condensate product and debutanizer tower-top reflux are bottoms from the reflux drum. The C_3-C_4 product goes to the catalytic fractionation and recovery unit depropanizer. C_4-free, 350°F. end point reformed naphtha, as bottoms from the debutanizer, passes through an exchanger and cooler to motor gasoline storage. Tail gas from the entire operation is taken overhead from the absorber to the refinery fuel gas system.

The absorber is operated to recover 100 per cent of the B-B fraction and approximately 50 per cent of the C_3 fractions. The absorber is 73 ft. 6 in. by 8 ft. I. D. It contains 30 trays on 24-in. centers. It is designed for a pressure of 125 lb. per sq. in. gauge. The bottom temperature is 120°F. and the top temperature is 110°F.

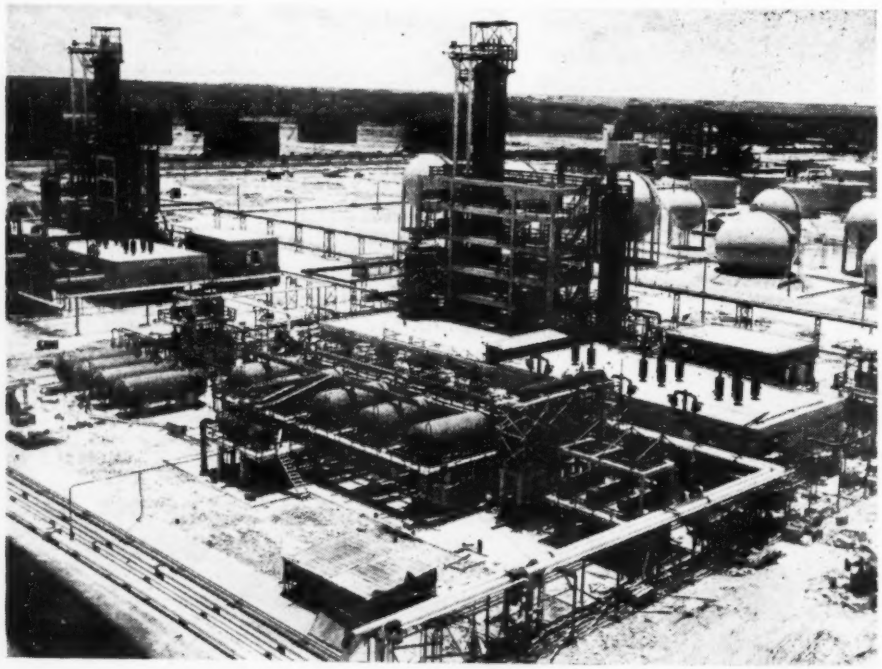
The debutanizer is 73 ft. by 6 ft. I. D. It contains 24 trays on 30-in. centers. It is designed for a pressure of 290 lb. per sq. in. gauge. The bottom temperature is 440°F. and the top temperature is 145°F.

Table 5 details inspections of naphtha feed and products.

Gas Recovery and Fractionation Unit

The gas recovery and fractionation unit exerts a pronounced effect on operations conducted in the catalytic cracking section of the refinery and, because of this, extreme flexibility is the aim of its design.

Alkylation unit "B" looking southwest



As a result of this system's flexibility any two operations can be conducted in the catalytic cracking units at one time. Such operations include the normal in which two units make re-treat feed for the third unit, which makes aviation base; or one unit may make once-through aviation base while the other two units make motor gasoline. In any case, the C_3 and lighter, total B-B, and the total C_5 fractions may be obtained.

The flexibility of this gas recovery and fractionation unit has definite postwar values. At the present, the great and almost total demand is for 100-plus octane and secondary aviation gasolines with almost no demand, comparable to peacetimes, for motor gasolines. In the postwar era, this situation will be reversed in which case one catalytic cracking unit can make aviation fuel while the other two units make motor gasoline.

The principal components of the gas recovery unit are an absorber, lean oil still, splitter tower, depropanizer, debutanizer, and re-treat fractionator.

Feed to the unit is liquids and gases from the three catalytic cracking unit bubble towers at an incoming pressure of 60 lb. per sq. in. gauge to 70 lb. per sq. in gauge.

Liquids and gases as overhead from the "A" and "B" catalytic cracking units are recontacted, cooled, and enter a high-pressure feed flash drum. The overhead vapors from this drum go to the absorber.

The absorber is 77 ft. by 10 ft. 6 in. I. D. It contains 30 trays on 24-in. centers and is designed for a pressure of 220 lb. per sq. in. gauge. The bottom temperature is 108°F. and the top temperature is 84°F. Lean oil is refrigerated with ammonia to assure 100 per cent recovery of the B-B fraction.

The overhead from the absorber goes to plant fuel. The rich oil from the bottom passes through a heat exchanger and a gas-fired preheater to the lean oil still.

The lean oil still is 78 ft. by 12 ft. I. D. It contains 18 trays on 24-in. centers. It is designed for a pressure of 90 lb. per sq. in. gauge. The bottom temperature is 540°F. and the top temperature is 260°F. The column is equipped with a gas-fired reboiler.

The condensables overhead from the still pass through a cooler to the splitter tower, which also receives the liquid from the base of the feed flash drum.

Splitter

The splitter tower is 88 ft. by 12 ft. 6 in. I. D. It contains 30 trays on 24-in. centers. It is designed for a pressure of 85 lb. per sq. in. gauge. The bottom temperature is 375°F. and the top temperature is 165°F. The column has a

TUBE-TURN WELDING FITTINGS—RANGE OF SIZES

Type of Fitting	Description	Standard Weight	Extra Strong	Schedule 160	Double Extra Strong	Light Gauge Nominal Pipe Size	Light Gauge Iron Pipe Size
Elbows	90° Long Radius	½"-24"	¾"-24"	1"-12"	1"- 8"	4"-24"	3"-12"
Elbows	90° Short Radius	1"-30"	1½"-30"				
Elbows	45° Long Radius	½"-30"	¾"-30"*	1"-12"	1"- 8"	4"-24"	3"-12"
Returns	180° Long Radius	½"-24"	1"-24"	1"-12"	3"- 8"	4"-24"	
Returns	180° Short Radius	1"-30"	1½"-30"				
Returns	180° Extra Long Radius	1"-2½"	1"-2½"				
Tees	Straight	¾"-24"	¾"-24"	1"-12"	1"- 8"		
Tees	Reducing Outlet	¾"-24"	¾"-24"	¾"-12"	1"- 8"		
Reducers	Concentric & Eccentric	1x½-24x20	1x½-24x20		1x½-12x10		
Caps		1"24"	1"-24"		1"- 8"		
Stub Ends	Lap Joint	1"24"	1"-24"				
Nipples	Shaped, 90° to Header	1¼"-12"	1¼"-12"				
Nipples	Shaped, 45° to Header	1¼"-12"	1¼"-12"				
Saddles			2"-24"**				
Laterals	Straight	1¼"-24"	1¼"-24"				
Laterals	Reducing-on-Run	1¼"-24"	1¼"-24"				
Crosses	Straight	¾"-24"	¾"-24"				
Rings	Welding	¾"-12"	¾"-12"				
Sleeves	Welding		2"-24"**				

*30" size short radius.

SUPER Tube-Turn 45° long radius elbows, 90° long radius elbows, and 180° long radius returns available in both Standard weight and Extra Strong in sizes from 3" to 12".

Tube-Turn welding fittings and flanges conform to applicable ASA and ASTM Standards. For further details please refer to Tube Turns catalog and data book No. 111.

**Since saddles and sleeves are used for external reinforcement only, they do not conform to iron pipe size thicknesses.

TUBE-TURN FORGED STEEL FLANGES—RANGE OF SIZES

	150 Lb.	300 Lb.	400 Lb.	600 Lb.	900 Lb.	1500 Lb.	2500 Lb.
Welding Neck	½"-24"	½"-24"	½"-24"†	½"-24"	½"-24"*	½"-24"	½"-24"
Slip-On	½"-24"	½"-24"	½"-24"†	½"-24"	½"-24"*	½"-24"	½"-24"
Lap Joint	½"-24"	½"-24"	½"-24"†	½"-24"	½"-24"*	½"-24"	½"-24"
Threaded	½"-24"	½"-24"	½"-24"†	½"-24"	½"-24"*	½"-24"	½"-24"
Blind	¼"-24"	¼"- 4"		¼"-3½"			
Socket Type	¾"-24"	¾"-24"	¾"-24"†	¾"-24"	¾"-24"*	¾"-24"	¾"-12"
Reducing-threaded or slip-on		1"-24"	4"-12"	4"-12"	3"-12"	1"-12"	
Orifice—threaded		1"-24"					
Orifice—slip-on		1"-24"	4"-12"	1"-12"	1"-12"	1"-12"	
Orifice—welding neck		1"-24"	1"-10"	1"-10"	1"-10"	1"-10"	
Long Welding Neck	1"-24"	1"-24"					

†Dimensions on sizes thru 3½" same as for 600 lb. flanges.
*Dimensions on sizes thru 2½" same as for 1500 lb. flanges.

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TRADE MARK
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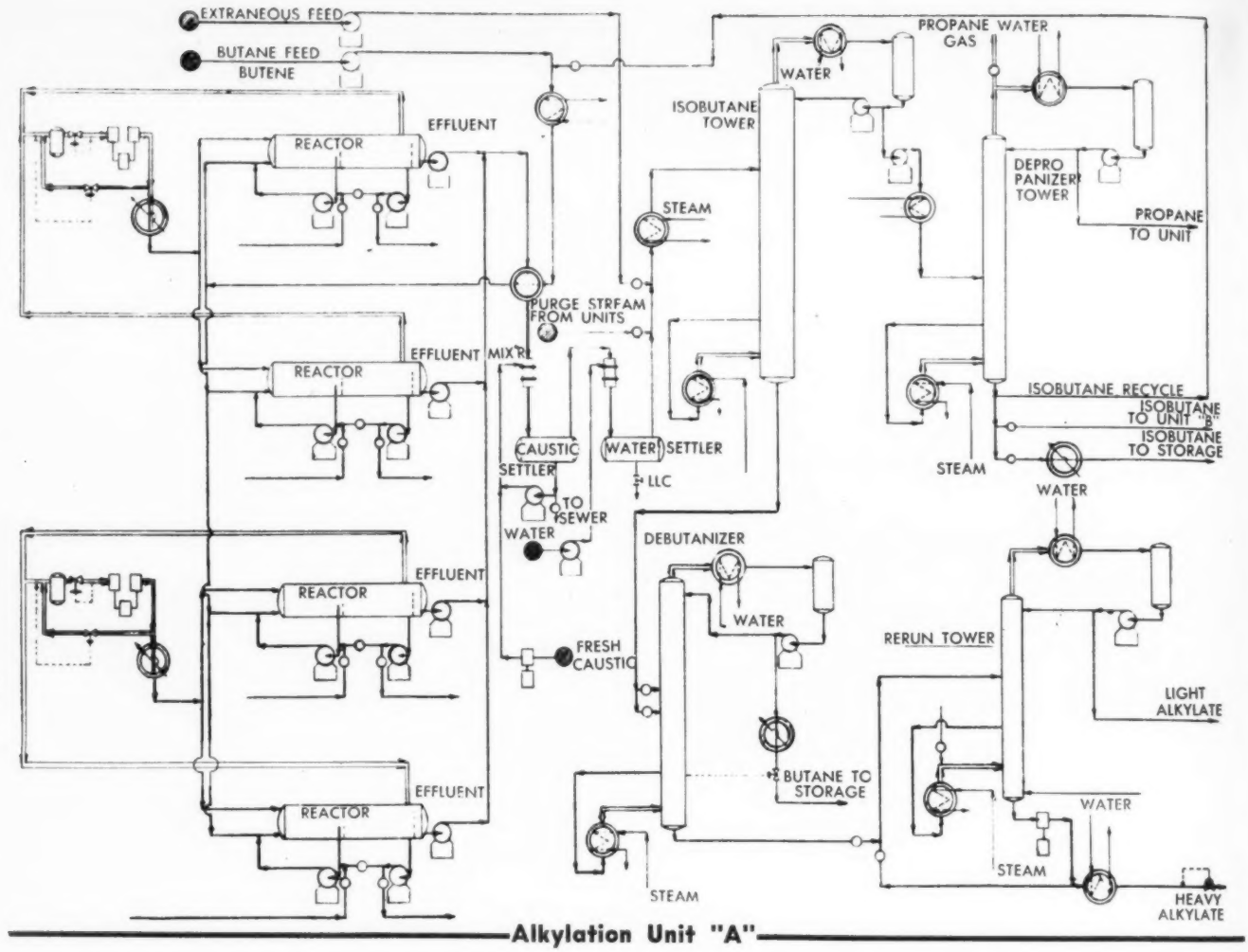


Alkylation Unit "A"

gas-fired preheater and reboiler, water-cooled overhead condenser and a reflux drum.

The feed is a C_3 and heavier up to and including 475°F. end point fraction. This tower splits the feed in the middle of the C_6 fraction. The overhead consisting of iso C_6 and lighter passes through the cooler to the reflux drum. Some of the overhead gas from the reflux drum is recycled back to the absorber. The iso C_6 and lighter fraction, from the bottom of the reflux drum, is pumped through a heat exchanger, which supplies preheat, and then goes to the depropanizer.

The splitter bottoms fraction boils from approximately 150°F. to 475°F. This makes up the major feed to catalytic cracking unit "C" for re-treating.

The depropanizer is 89 ft. 11 in. by 9 ft. 6 in. I. D. It contains 30 trays on 30-in. centers. It is designed for a pressure of 314 lb. per sq. in. gauge. The bottom temperature is 270°F. and the top temperature is 125°F. The column has a high-pressure steam reboiler, an overhead reflux condenser and reflux drum.

The feed to the depropanizer is iso C_6 and lighter from the splitter, which feed line is joined by the line carrying C_3 and C_4 condensables from the naphtha reforming unit debutanizer reflux drum.

The overhead from the depropanizer passes through the cooler to the reflux drum, the overhead from which is C_3 and lighter. This goes to the refinery's fuel gas system. Liquid from the bottom of the drum is pumped back over the depropanizer top tray as reflux.

Bottoms from the depropanizer consisting of C_4 through to iso C_6 form the feed to the debutanizer.

The debutanizer is 78 ft. by 9 ft. I.D. It contains 30 trays on 24-in. centers. It is designed for a pressure of 115 lb. per sq. in. gauge. The design bottom temperature is 245°F. and the top temperature is 142°F. The column has a high-pressure steam reboiler, overhead condenser and reflux drum.

Feed to the column is the previously mentioned C_4 through iso C_6 fraction. The overhead B-B passes through the cooler to the reflux drum from the bottom of which the top tray reflux and the product are drawn. The B-B is cooled and sent to the butadiene plant where the normal butylenes are removed and the remainder is then returned to the refinery as feed to the "A" alkylation unit.

The bottoms from the debutanizer, a C_5 to 150°F. end point fraction, form the feed to the "B" alkylation unit.

Re-Treat Fractionator

Overhead gases and liquids, cut to 340°F. end point, from the "C" catalytic cracking unit bubble tower enter the gas recovery and fractionation unit at a pressure of 60 to 70 lb. per sq. in. gauge, are recontacted, cooled, and enter a separate feed flash drum. The overhead from this drum joins the overhead from the feed flash drum fed by the "A" and "B" catalytic cracking units and, in the common line, goes to the absorber.

Bottoms from the feed flash drum pass through preheaters to the re-treat fractionator tower.

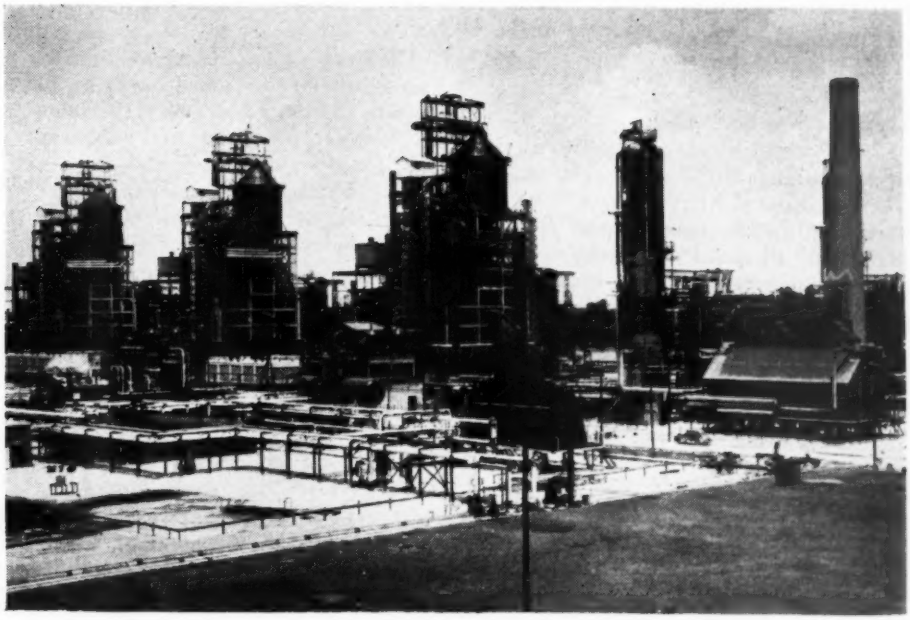
The re-treat fractionator tower is 63 ft. by 7 ft. 6 in. I. D. It contains 22 trays on 24-in. centers. It is designed for a pressure of 95 lb. per sq. in. gauge. It is equipped with an overhead condenser and reflux drum with water tap.

Overhead passes through the cooler to the reflux drum. The overhead gas from the drum joins the products going to the absorber. Bottoms from the re-treat fractionator are C_5 to 340°F. end point aviation base stock.

Alkylation Units

There are two sulphuric acid alkyla-

TUBES matched to the job



General View—Lake Charles, Louisiana, 100-Octane Aviation Gasoline Plant of the Cities Service Refining Corporation

. . . at City Service Lake Charles Plants

Fuel for a thousand bombers over Germany daily . . . material for 12 million synthetic tires yearly . . . these are the imagination-staggering capacities of Cities Service Refining Corporation's mammoth 100-octane and butadiene plants at Lake Charles—*now on stream* —an accomplished fact!

Many unusual engineering problems had to be solved before this first completely *new,* wholly integrated aviation fuel and butadiene plant was successfully completed. In it many time-tried products helped.

In the application of steel tubes to refinery requirements, Babcock & Wilcox Tubing experience was relied upon. Refiners recognize the more than 20 years' specialized tubing experience that is behind B & W technical advice. Therefore, tubing furnished by B & W for Lake Charles has the right combination of chemical analyses required to match each job.

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SEAMLESS TUBE DIVISION
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B & W MAKES BOTH

tion units in the refinery identified as "A" and "B." This dual installation possesses considerable flexibility as the "A" unit handles C_{4s} and can handle C_{3s}. The "B" unit handles C_{5s} and can handle C_{4s} or C_{3s}. If the capacity of the "A" unit is exceeded when C_{3s} are being added, C_{4s} may be diverted to the "B" unit and handled in addition to the C_{5s}.

"A" Unit

The olefin charge to the "A" unit is deisobutylene (cold acid dimer) from the butadiene plant plus some n-butylenes and n-butylene dimers. These olefins are alkylated with isobutane in four Kellogg-type reactors employing refrigeration for temperature control. The catalyst is sulphuric acid.

The butene dimer—isobutane mixture—is mixed with sulphuric acid to form the emulsion in which the reaction takes place. The reaction has the net effect of breaking down a dimer molecule into two butene molecules and then joining the butene and isobutane molecules to form isooctane.

The effluent from the reactors is caustic-washed to remove all traces of acid and then water-washed to remove the caustic after which it is preheated and fed to the unit's deisobutanizer tower.

The deisobutanizer is 114 ft. 6 in. by 13 ft. 6 in. I. D. It contains 50 trays on 24-in. centers. It is designed for a pressure of 105 lb. per sq. in. gauge. The design bottom temperature is 200° F., and the top temperature is 137°F. It is equipped with an overhead total condenser using water as a cooling medium, a reflux drum, and a steam reboiler.

The overhead is isobutane and lighter. This is totally condensed and goes to the reflux drum from which the tower's top tray reflux and the isobutane and lighter are drawn. The product is pumped through a preheater to the depropanizer. Bottoms from the tower go to the debutanizer.

The depropanizer is 85 ft. by 6 ft. I. D. It contains 28 trays on 24-in. and 30-in. centers. It is designed for a pressure of 250 lb. per sq. in. gauge. The design bottom temperature is 200°F. and the top temperature is 115°F. The column is equipped with a water-cooled overhead total condenser, a reflux drum, and a high-pressure steam-heated reboiler.

The overhead is C_3, some of which goes to plant fuel. The balance is totally condensed and from the reflux drum is, in part, recycled over the top tray of the depropanizer with the net product going to the deasphalting unit for propane makeup. Bottoms from the depropanizer is isobutane, which is recycled back to the unit's reactors, sent to the "B" alkylation unit, or sent to storage.

Bottoms from the deisobutanizer consisting of n-butane and total alkylate, go to the debutanizer.

Debutanizer

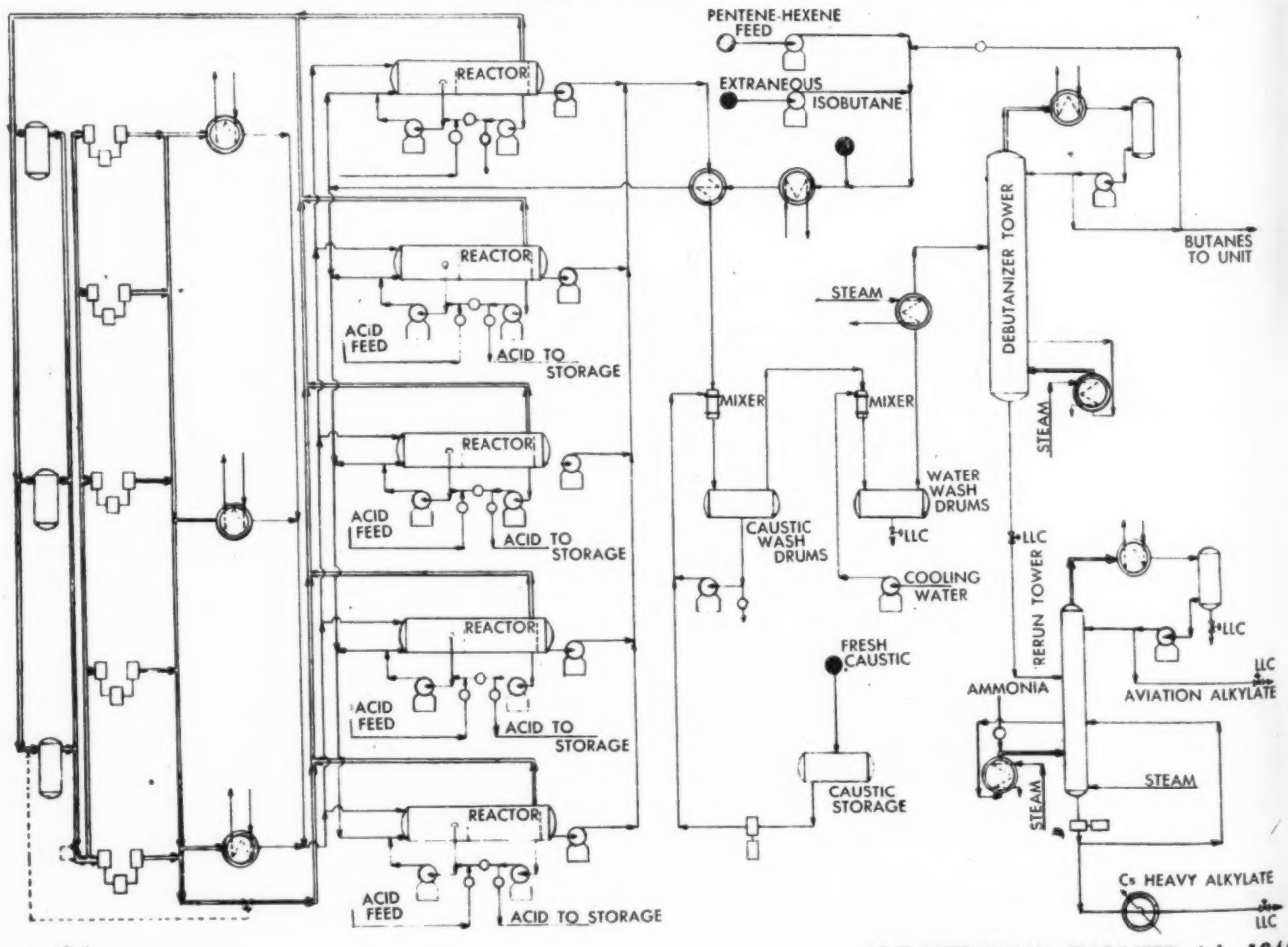
The debutanizer is 67 ft. by 7 ft. I. D. It contains 24 trays on 30-in. centers. It is designed for a pressure of 100 lb. per sq. in. gauge. The bottom temperature is 320°F. and the top temperature is 132°F.

The overhead is n-butane, which is totally condensed and from the reflux drum, the tower is refluxed and the product is sent to the isomerization unit or storage after passing through a product cooler. The bottoms product is C_4-free total alkylate, which goes to the rerun tower.

The rerun tower separates aviation alkylate from the small amount of heavy alkylate, the heavy alkylate being subsequently blended in motor fuel. The aviation alkylate goes to 100-octane aviation gasoline blending.

The rerun tower is 49 ft. by 5 ft. 6 in. I. D. It contains two sections and has 14 trays in the upper section and 2 trays in the bottom or steam stripping section. It is designed for a pressure of 36 lb. per sq. in. gauge. The design bottom temperature is 365°F. and the top temperature is 215°F. It is

Alkylation Unit "B"

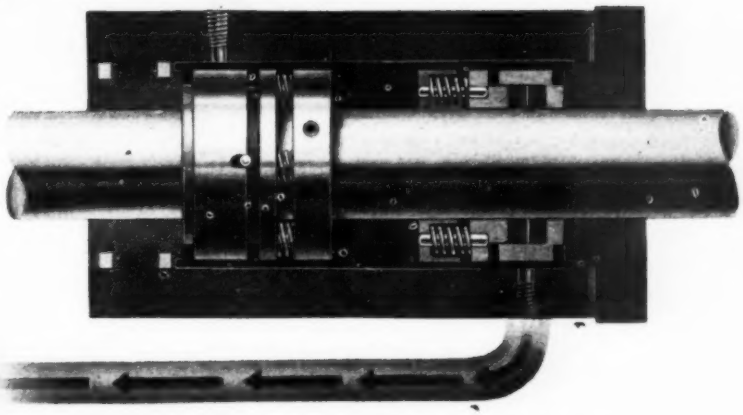


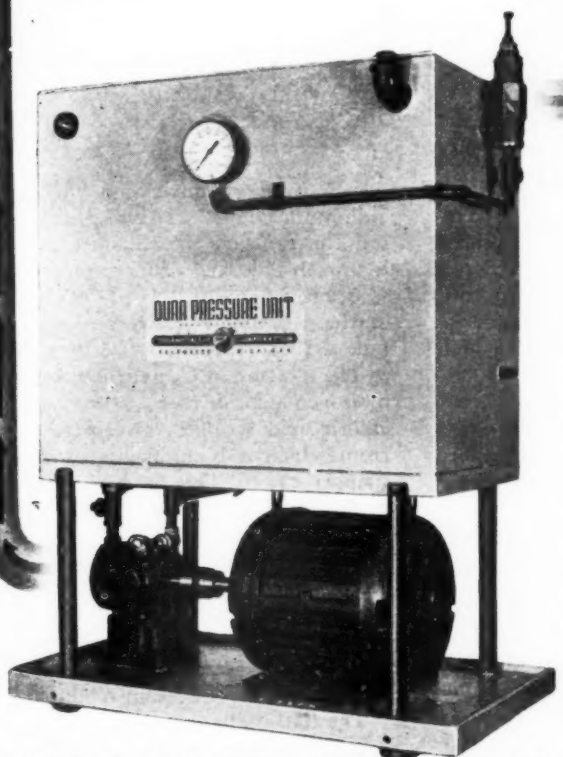
Congratulations!

CITIES SERVICE REFINING CORP. and M.W.KELLOGG COMPANY

on the New Aviation Gasoline and Butadiene Plant at Lake Charles, La.

Illustration on the right shows a Double Dura Seal, the mechanical sealing device originated by Durametallic. The view below shows a Dura Pressure Unit, compact Durametallic equipment for circulating lubricating oil at uniform pressure.





DURA PRESSURE UNIT
for circulating lubricating oil at uniform pressure

DURA SEAL
ROTATES WITH THE SHAFT

America takes off its hat to the Cities Service Refining Corporation and M. W. Kellogg Engineers who conceived and constructed the tremendous Aviation Gasoline and Butadiene plant at Lake Charles, Louisiana!

Durametallic SINGLE and DOUBLE DURA SEALS, we are proud to say, are meeting many severe sealing requirements in this great plant including Butane, Propane, Caustic, fatty acids and Sulphuric Acid. A battery of DURA PRESSURE UNITS are installed for supplying lubricating oil at uniform pressure to stuffiing boxes housing DURA SEALS.

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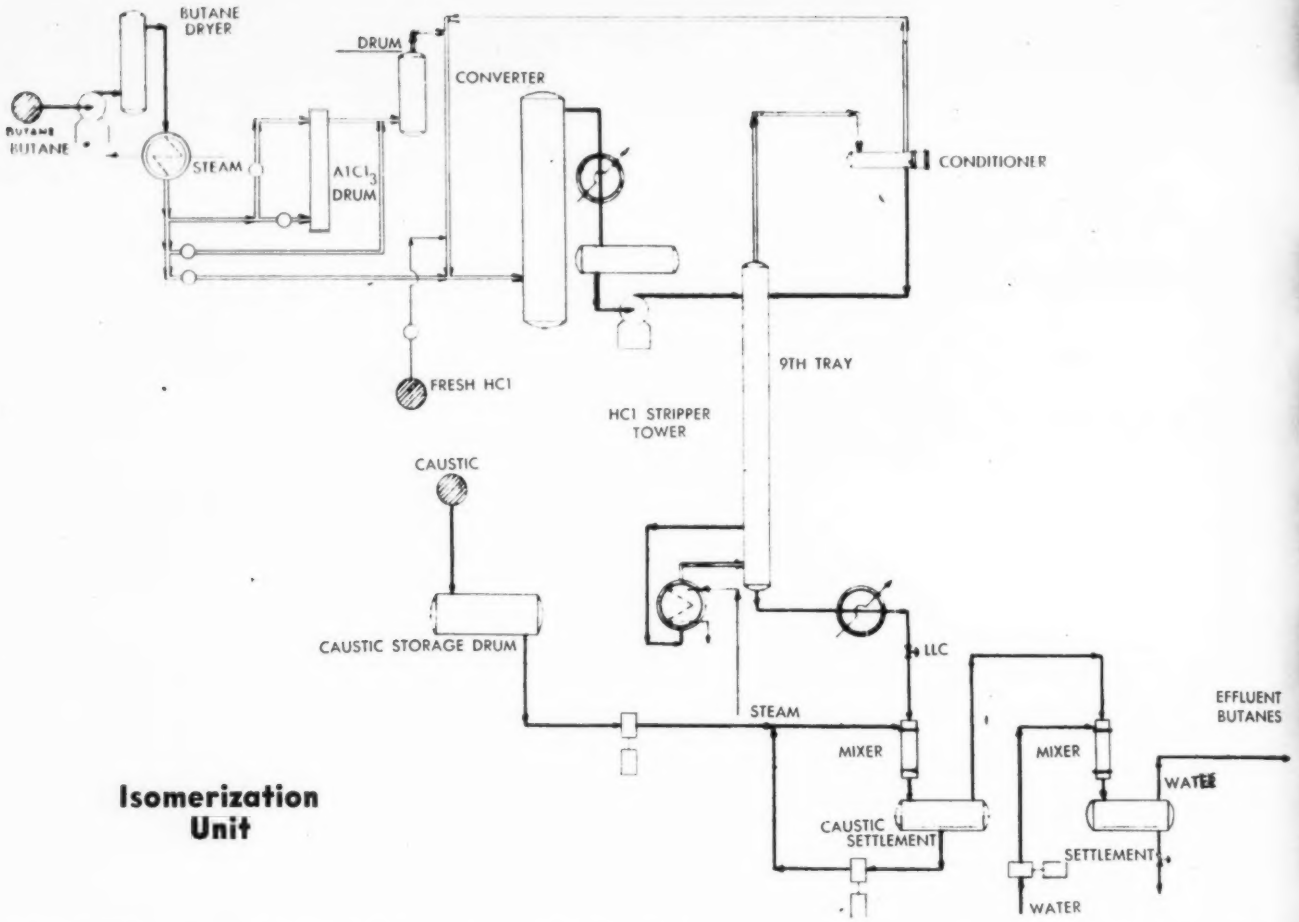

Isomerization Unit

equipped with an overhead water-cooled total condenser, reflux drum and a steam heated reboiler.

Light alkylate to aviation blending is the overhead. The bottoms are recirculated back to the column's fractionating section due to the fact that this stream is small compared to the total feed. This is done to assure proper maintenance of the column's liquid level and to assure the proper degree of fractionation. The bottoms net product is withdrawn from the circulating feed and goes to motor gasoline blending as previously stated.

"B" Alkylation Unit

The function of the "B" alkylation unit is to alkylate the C_5 to 150°F. fraction from the catalytic cracking units. The olefins in this fraction are alkylated with isobutane.

This system is similar to the "A" unit with the exception that it has 5 reactors and a simplified tower system that is partially dependent on the "A" unit deisobutanizer. The reactor effluent is caustic- and water-washed as in the "A" unit and charged to the "B" unit's debutanizer, which is identical with the "A" unit's deisobutanizer.

The overhead from the "B" unit's debutanizer consists of n-butane and lighter, some of which is returned to the "A" unit's deisobutanizer for reconcentration of the isobutane.

The bottoms, consisting of C_5 saturates—predominantly isopentane—and total alkylate, and charged to the "B" alkylation rerun tower. The overhead from the rerun tower is C_5 saturates plus light alkylate, which goes to 100-octane aviation gasoline blending. Bottom product is heavy alkylate, which contains approximately 50 per cent of motor gasoline boiling range material, the balance being light gas oil. This heavy alkylate is fed to the intermediate reflux return on the "C" catalytic cracking unit bubble tower where it is fractionated to produce motor naphtha and No. 2 or No. 6 fuel oil base.

Isomerization Unit

The feed to the isomerization unit is n-butane from the top of the alkylate debutanizer in the "A" alkylation unit or from storage. The isomerized product is returned to the "A" alkylation unit's deisobutanizer where the isobutane produced is made available to the alkylation units.

Normal butane is charged through bauxite driers to remove any moisture. The overhead from the driers passes through two high-pressure steam preheaters and thence to two aluminum chloride drums connected in parallel. Normally, part of the stream is fed through one of the drums to keep the concentration of the material constant in the reactors to which the stream now passes.

The two reactors are filled with a porous catalyst support on which the aluminum chloride is held. Also entering the reactors is a small stream of hydrogen chloride, which promotes the reaction. Approximately 35-50 per cent of the n-butane is converted to isobutane in these reactors.

The mixture of C_4 hydrocarbons and hydrogen chloride then enters an hydrochloric acid stripper tower feed drum from which it is pumped to the HCl stripper tower. This tower is 54 ft. 6 in. by 4 ft. I. D. It contains 20 trays on 24-in. centers. It is designed for a pressure of 385 lb. per sq. in. gauge. Its design bottom temperature is 245°F. and its top temperature is 165°F. It is equipped with a combination reflux drum and a water-cooled condenser and a high-pressure steam reboiler.

The feed is charged to the top of the stripper. The overhead is HCl, which goes to the reflux drum. The HCl leaves the side of the drum and is recycled back to the reactors. Makeup HCl is added to this line when necessary.

The bottoms from the stripper tower a mixture composed of isobutane and n-butane, which is passed through a product cooler, caustic-washed, water-washed and sent to the "A" alkylation unit for fractionation.

Treating Plant

The refinery's treating plant consists of the following units: Clay treating, acid treating, caustic and methanol

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by MARLEY

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CITIES SERVICE CORPORATION

Lake Charles, La., as at scores of other war-vital plants,

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MARLEY COOLING TOWERS

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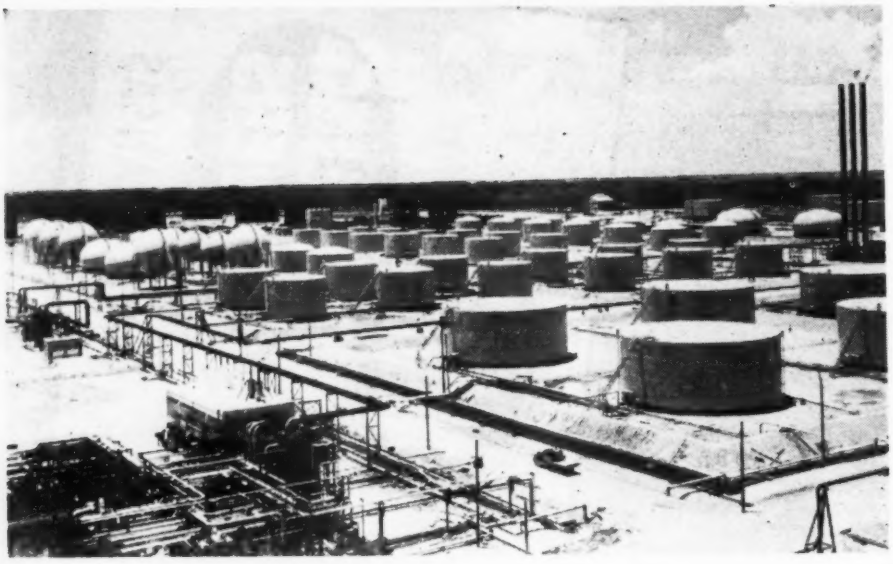


Intermediate storage area looking southwest

treating, caustic-washing, inhibiting, and doctor sweetening.

Products of the refinery receive the following treating or treatings: Kerosine is clay treated and doctor sweetened. B-B, straight-run isopentane, C_5 and straight-run butanes are caustic-washed. Straight-run light naphtha is caustic methanol-treated. Aviation gasoline is caustic-washed and inhibited. Furnace oil is acid-treated and caustic-washed. Motor gasoline is caustic methanol-treated and inhibited.

Facilities are available at the refinery for blending "CS" in aviation gasoline. This unit adjoins the treating plant as does an ethylizing plant.

Spent Acid Regeneration Plant

The function of this unit is to take spent sulphuric acid from the alkylation units and the treating plant and from the butadiene plant sludge and regenerate it to produce 98 per cent strength white sulphuric acid.

The sludge is burned in a decomposition furnace to produce SO_2 gas. After purification, the SO_2 gas goes to conventional-type converters and, in the presence of a vanadium mass catalyst it is oxidized to SO_3. This is absorbed with 98 per cent sulphuric acid and water to make a 98 per cent strength sulphuric acid product. The fresh acid is pumped to the alkylation units, the treating plant and the butadiene plant feed concentration unit.

The unit is self-contained. It can operate on sludge, mercaptans, both gaseous and liquid, or sulphur. The plant has a capacity of 350 tons per day. It was designed by the Chemical Construction Company.

The acid flow through the refinery is as follows: Fresh 98 per cent strength sulphuric acid is fed to the "A" alkylation unit and then, at approximately 94-96 per cent strength, to the "B" alkylation unit after which it is returned at 85-88 per cent strength for regeneration. Fresh 93-98 per cent acid is supplied to the treating plant and fresh 98 per cent acid goes to the butadiene plant.

Pilot Plant and Chemical Lab

A pilot plant has been set up to guide the operations of the entire refinery and for the conduct of research projects with the objective of improving process operations and design. The pilot plant further functions to set up operating conditions for the various processing units when contemplating running different crudes that may be made available from time to time.

The pilot plant contains a 7-bbl. per day topping unit, a 2-bbl. per day fluid catalytic cracking plant and a ½-1 bbl. per day deasphalting unit.

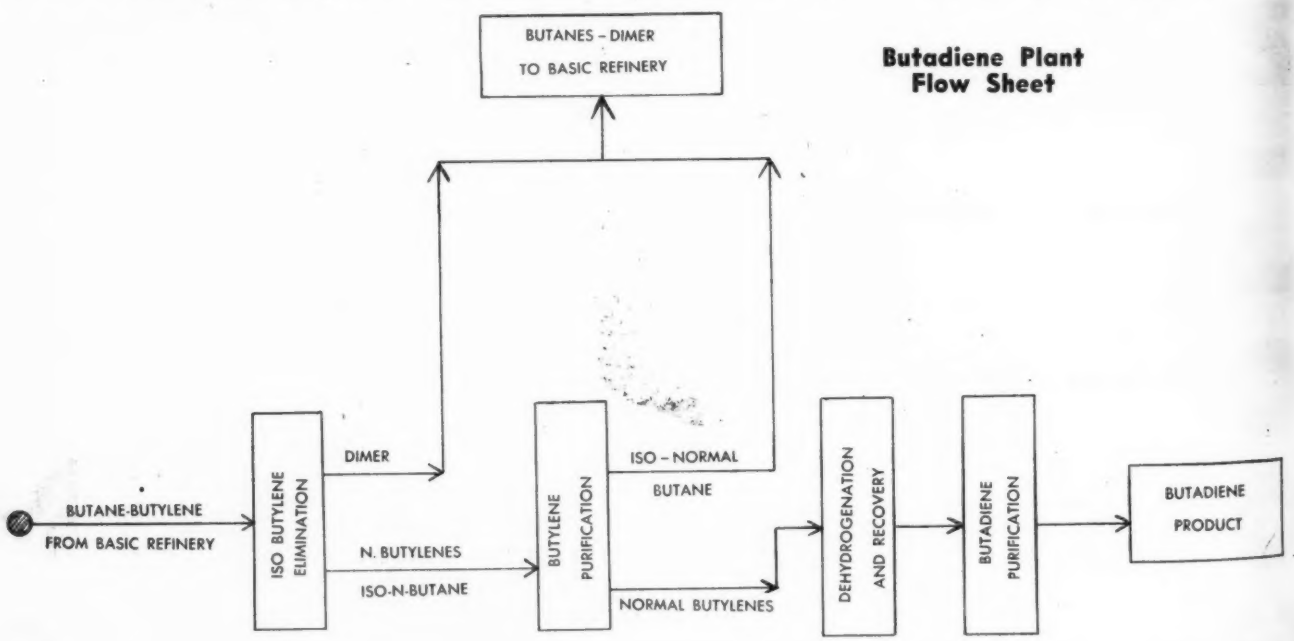
The preheater coils on the pilot plant topping unit are so designed that thermal cracking operations may be run on this unit at moderate throughputs.

The catalytic cracking pilot plant unit is provided with catalyst recovery equipment, which can retain essentially 100 per cent of the catalyst being circulated. It therefore permits accurate studies of the effects of the many process variables on the rate of catalyst activity loss. These studies are used for the purpose of improving design and for improving operation of the refinery-scale units to secure maximum catalyst activity levels.

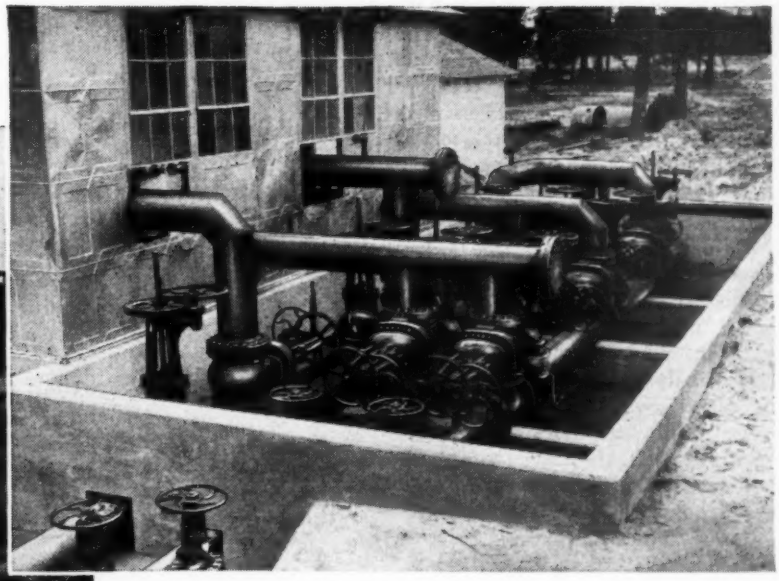
Runs of any type of reduced crude may be made in the deasphalting and desalting pilot plant to determine the optimum deasphalting conditions for producing high-grade catalytic cracking feed stock and for fuel oil base.

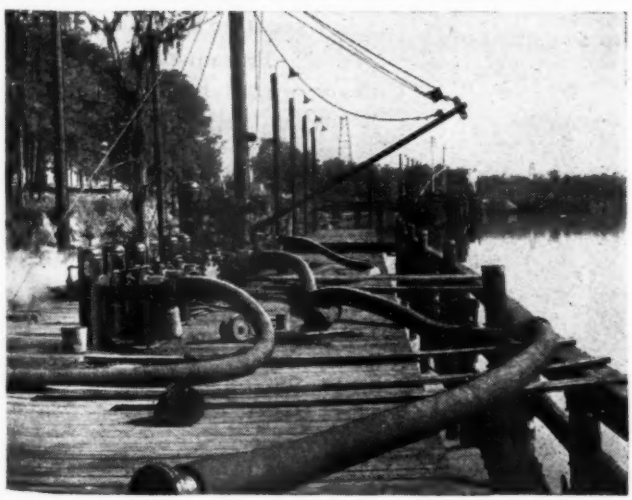
All three pilot plant units are equip-

Butadiene Plant Flow Sheet



GRAVER HELPS CITIES SERVICE BUILD FOR AMERICA'S FUTURE





NEEDED NOW for war, the new 100 octane and butadiene plant of Cities Service will nevertheless become another building block in our country's future. The Construction Division of Graver played a prominent part in the erection of the two tank farms for this project. Graver congratulates Cities Service for undertaking the erection of this vitally needed plant.

All excavating, roads, telephone and power lines . . . as well as piping and all facilities for barge and ship loading operations were entrusted to Graver for construction and successful completion.

This work at Lake Charles, Louisiana, is another example of Graver's ability to handle the complex and exacting requirements of building for the Petroleum Industry. Send us your specifications and blueprints for complete estimates.

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ped with special instruments and measuring devices so that information of value may be obtained that is difficult or impossible to obtain on the refinery-scale unit.

Chemical Laboratory

The chemical laboratory contains the latest and most modern equipment for running various analyses and control tests, and it is further set up for chemical engineering research.

Included in the laboratory's equipment are four of the latest type hydrobot low temperature Podbielniak distillation units; two 3-c rich-mixture octane determination engines; two 1-c octane engines; two CFR (CFRM and CFRR) engines and one cetane engine. There is also one infra-red spectrophotometer.

Much laboratory equipment is required in connection with catalytic cracking. The laboratory has special Roller analysis apparatus that is used for determining catalyst particle size. Special miniature fixed-bed catalytic cracking units are used to determine catalyst activity by a standard method. The laboratory also has combustion equipment for determining the carbon content of catalyst at various points in the fluid catalytic cracking units.

Another feature of the laboratory is a 100-plate high reflux ratio column for precise fractionation of various refinery intermediate streams as well as various fractions of crude.

Butadiene Plant

The butadiene plant is located on an 85-acre tract of land adjoining the refinery. As has been stated, this plant is operated by Cities Service Refining Corporation and owned by the Defense Plant Corporation.

The butadiene plant is designed for the manufacture of 55,000 tons of butadiene per year and it supplies its product to an adjoining copolymerization unit operated by the Firestone Tire and Rubber Company and owned by the Defense Plant Corporation.

The units of the butadiene plant include an isobutylene extraction unit, a butene purification unit, a butene dehydrogenation and gas recovery unit, and a butadiene purification unit. The supporting facilities are a steam generation plant, water purification plant, a two-stage ammonia absorption refrigeration unit, a chemical laboratory, and product storage facilities.

Processing

The B-B (butane-butylene) charge for the butadiene plant is received from the refinery and charged to the isobutylene extraction section where the isobutylenes are extracted with cold sulphuric acid and polymerized and, as dimer, returned to the refinery.

The isobutane, n-butane, and n-butylenes remaining are sent to the butene purification section where the butenes are removed by extractive distillation. The remaining n-butane and isobutane are combined with dimer from the cold acid extraction section and returned to the refinery's "A" alkylation unit.

The purified butenes are diluted with steam and catalytically dehydrogenated at high temperature and low pressure. The reactors are of the stationary bed-type, operating on one hour cycles of reaction and regeneration. The products are quenched and the sensible heat is recovered by waste heat boilers, which generate 200 lb. process steam. Further quenching is effected by circulating lean oil, which is subsequently used to supply heat duty to other equipment in the plant such as reboilers, preheaters, etc.

The steam in the reactor effluent is condensed in the ammonia refrigeration unit reboilers thus supplying the heat requirements of the ammonia absorption refrigeration system.

The C_4 fraction from the reactors is now recovered and sent to the butadiene recovery and purification unit, butadiene from which goes to storage.

Utilities and Facilities

The steam generation plant consists of twin boiler units that generate a total of 500,000 lb. per hr. of saturated steam at a pressure of 400 lb. per sq. in. gauge and 350,000 lb. per hr. of superheated steam at a temperature in excess of 1000°F. and a pressure of 50 lb. per sq. in gauge. The superheated steam is supplied to the dehydrogenation reactors. The waste-heat boiler makes 150,000 lb. per hr. of saturated steam at a pressure of 200 lb. per sq. in. gauge.

There is a 2-stage ammonia absorption refrigeration unit for refrigerating the spheroids and condensers in the plant. The make is 1392 tons per day at 45°F. and 2055 tons at minus 5°F.

Acknowledgments

The writer is indebted to W. W. Lowe, A. P. Frame, and George C. Keller for the many courtesies shown him during his visit to the refinery and he particularly acknowledges the efforts of K. G. Holdom, process engineer, for collecting and orienting the basic data from which the refinery section of this article was prepared and the similar efforts of A. J. Surowiec, process engineer, for the data from which the butadiene plant section was written.

Executive Staff and Key Personnel of Cities Service Refining Corporation

W. Alton Jones, chairman of the board.
Temple W. Tutwiler, president.
W. W. Lowe, vice president and general manager.
A. P. Frame, vice president and chief engineer.
Lloyd Lynd, treasurer.
E. W. Korsmeyer, secretary.
Harris Bateman, purchasing agent.
E. H. Roy, general superintendent.
G. L. Mateer, assistant general superintendent.
Gordon Gano, crude supply.
B. R. Muirhead, sales and transportation.
W. T. Cravens, process engineering.
W. H. Price, process superintendent.
W. W. Scheumann, chief chemist.
C. B. Whyte, chief plant engineer.
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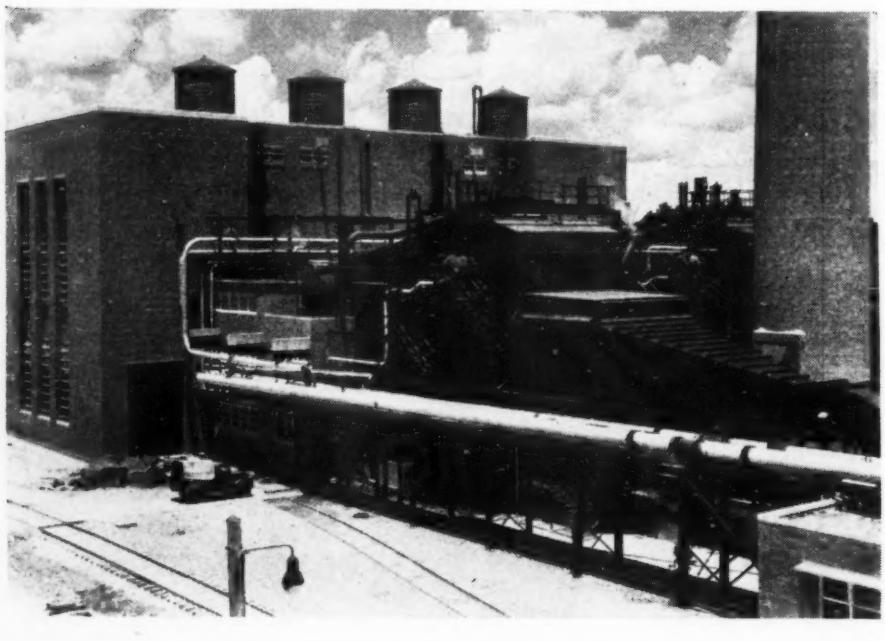
B. R. Johnstone, office manager.
George Keller, public relations.

High-pressure boilers



Well Completions Facilitated by Liner Shut-off Equipment

PETROLEUM ENGINEER Exclusive Feature

☆ Positive seal effected between top of liner and shoe of water string

by Henry G. Abadie

Petroleum Engineer, Kettleman North Dome Association

THE bypass control collar and accessories discussed in this article were developed to facilitate well completions in the Kettleman Hills North Dome field, Kings and Fresno counties, California. The bypass port coupling and accessories permit: The setting of a packoff type liner hanger; disengaging from the hanger; cementing the liner blank section below the port coupling, and closing the ports to complete the seal around the top of the liner. A positive seal between the top of the liner and the shoe of the water string is assured through the use of this equipment.

The complete bypass port coupling equipment consists of the port coupling, the splined nipple, and the packoff coupling. (Figs. 1, 2, and 3, respectively.)

Development of Equipment

An explanation of the conditions surrounding the development of this equipment will serve to demonstrate its value.

The Temblor pool of the Kettleman Hills North Dome field consists of a series of productive sands, each sand having its gas cap. In 1937, the drilling activity was shifted from the North to the South Temblor and a new casing program was adopted by the operators for this section of the field. The point of primary water shutoff was made above the first productive sand in the Temblor or above a horizon of lost circulation. The well was then completed with a liner that lapped the shoe of the water string. In many of the completions it was necessary to exclude upper high ratio sands to assure a low producing ratio.

The casing program of Well A is typical of one of the programs used in the South Temblor, as follows: 18⅝-in. surface casing cemented at 200 ft.; 11¾-in. conductor casing cemented at 5154 ft.; 8⅝-in. water string cemented at 6599 ft.; 6⅝-in. liner landed at 6549-8665 ft.

The liner for Well A included alternate blank and perforated intervals with cement ports for the top blank interval at 7336 ft. Due to the small clearance between the 7.50-in. O. D. plain liner hanger and the 7.775-in. I. D. of the 8⅝-in. casing, three ¾-in. holes were drilled in the top of the liner at 6554 ft. immediately below the hanger to reduce circulation pressures around the blank section. These holes would also assure circulation returns in the event that cuttings bridged around the liner hanger. Following the cementing of the top blank section, 3-in. tubing was landed at 7009 ft. and the well placed on production.

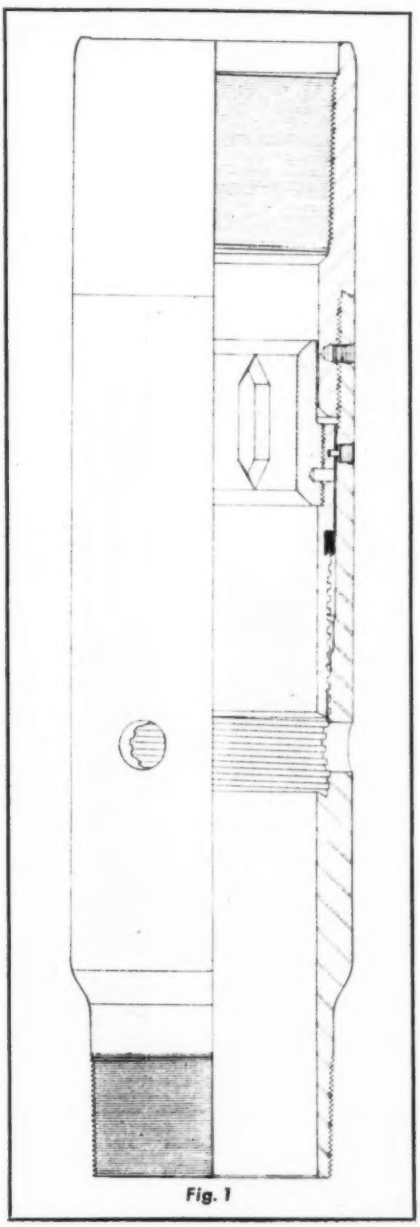


Fig. 1

The excessive gas rate on the initial production test indicated a possible failure in the top cemented blank section opposite the upper high ratio sands. This was confirmed by a flowing depth pressure survey. The well was then killed and the tubing pulled. Inspection of the tubing showed one small and two large gas cut holes at a point that corresponded to the fluid return holes of the liner at 6554 ft. The severity of the cutting indicated that in a few days the tubing would have been cut in two if the production rate had been maintained. Remedial steps required the recovery of the top liner section containing the holes. Two squeeze cement jobs were performed in an effort to effect a seal around the top of the liner. A test of the second cement job showed that the seal was incomplete. The well was completed with 3-in. tubing set on a packer in the 6⅝-in. liner at 6636 ft.

It was apparent then that in subsequent jobs the shutoff of gas and in some instances water around the top of the liner would be difficult. As cement channels, the use of excess cement is no insurance for obtaining the desired seal around the liner top. Other means would have to be taken to obtain the desired results without undue time and expense involved. Confronted by this problem, the bypass control collar and accessory equipment was developed. It is now available to the industry.

Description and Operation

The bypass port coupling is the essential part of the equipment. There are three or four holes in the body of the coupling of sufficient size to provide the desired area for return flow. On the inside of the coupling is a threaded packoff sleeve with projecting keys. These keys are engaged by the projecting ridges of the splined nipple. Rotation of the run-in string to the right moves

the bypass sleeve downward until the lower end seals in the recess of the port coupling. The design of the splined nipple permits complete freedom of movement through the sleeve at all times without danger of hanging up. The length of the splined nipple is sufficient to permit safe positioning opposite the keys of the port coupling. The packoff coupling is essentially a nipple with an internal rubber sleeve held in place by metal retaining rings. It is used to provide a positive seal around the tailpipe hanging below the run-in string.

To complete the assembly, a packoff liner hanger is required. It may be either a screw-down type or weight-expanding type of hanger. Lead is preferred as the packing element since it is more stable than packing rings when subjected to oil and heat. The liner hanger adapter used has been the J-slot adapter. Screw releasing type adapters have been used successfully, however.

In practice, the liner is completed with the bypass port coupling immediately below the liner hanger and the packoff coupling inserted in the string one joint down from the top of the liner. With the liner hanging in the table slips, the liner setting tool is made up with the splined nipple and the plain end tailpipe below. The tools are lowered into the liner and the liner hanger engaged by the setting tool with the splined nipple positioned below the bypass port coupling and the plain end tubing tail packed off in the packoff coupling. The end of the tail pipe is partially bullnosed and extends 10 to 12 ft. be-

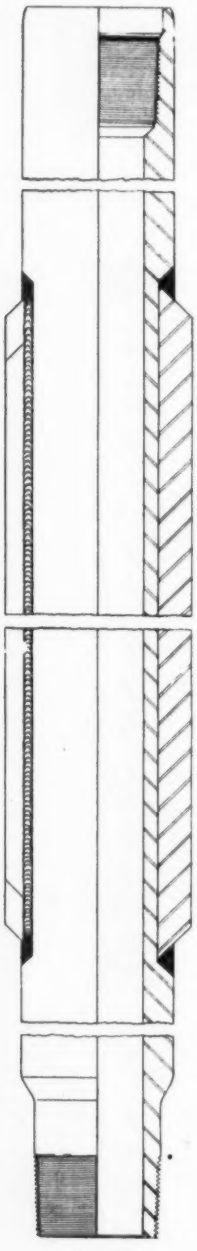


Fig. 2

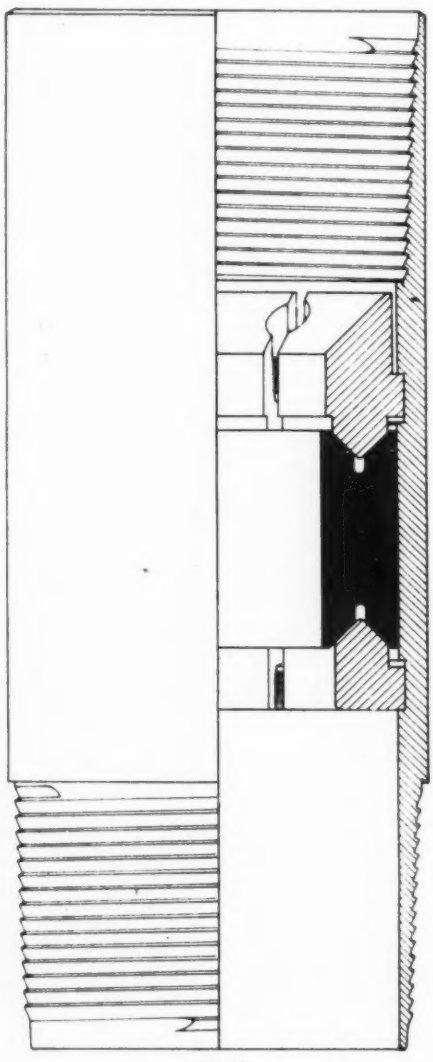


Fig. 3

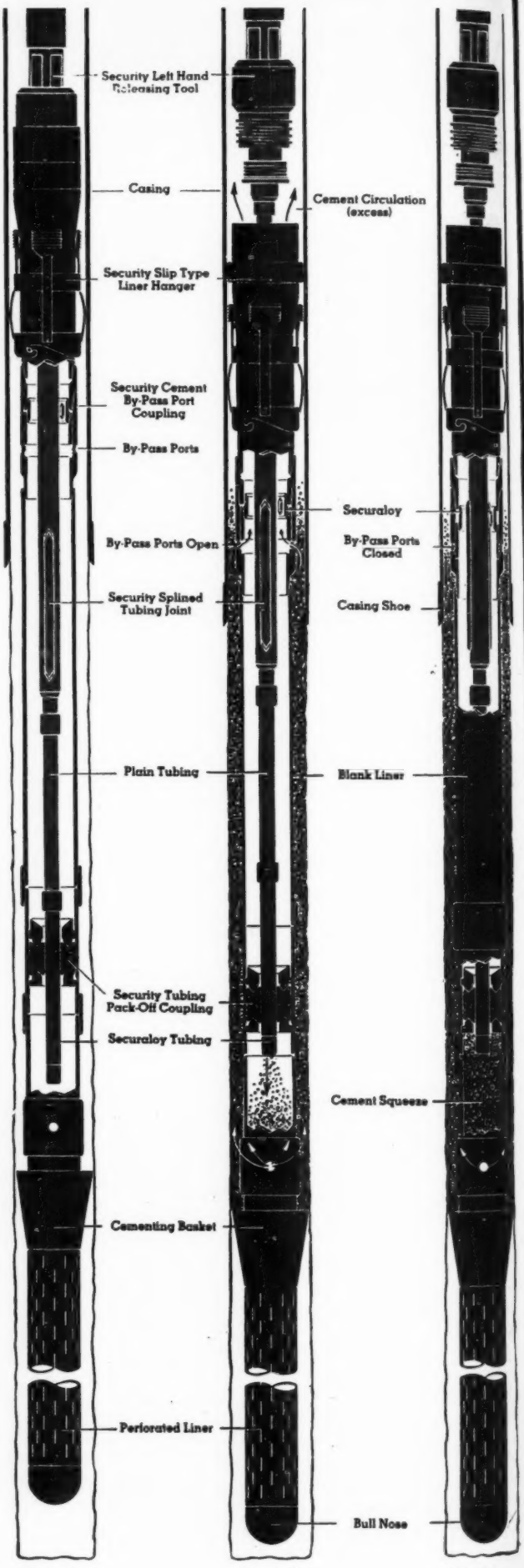


Fig. 4 Fig. 5 Fig. 6

low the packoff while in the running position.

The liner is run into the hole (Fig. 4) and bottom is checked and the liner pulled up 5 ft. and hung. The hanger is packed off and the setting tool disengaged from the liner top. The run-in string is raised 5 ft., which places the splined nipple in position. The ability to release from the liner is a desirable feature since this precludes any possibility of hanging up after the cement has been pumped around the blank section. Circulation is then established through the cement ports and around the top blank section with returns coming back into the liner through the circulation return holes of the port coupling. (Fig. 5.) The blank section is then cemented. While still holding the displacement pressure on the run-in string, the string is rotated the required number of turns to the right to close and seal the ports. (Fig. 6.) The string is raised to pull the tailpipe out of the packoff coupling. A clapper valve is always incorporated with the packoff coupling on jobs of this type. This prevents any tendency for equalization of the cement after the tail has been withdrawn from the packoff coupling.

Generally, there were two or more liner blank sections to be cemented. Often it was considered advantageous to cement the top blank section first because of its length. This method permitted cementing the blank section immediately upon landing the liner, thereby minimizing any possibility of the hole bridging before attempting to cement. Where there were a number of intervals to be cemented, however, and the importance of the top interval was not stressed, a different procedure was followed in the use of the bypass port coupling equipment.

A number of liners were run with series cementing equipment and the bypass port coupling equipment. This involved the use of a series cementing mandrel positioned below the lowermost series cementing collar while running in with the liner. The liner was hung and packed off in the customary manner. The liner setting tool was released from the top of the liner. Dogs on the cementing mandrel were released and the mandrel pulled up and seated on the first series collar. Each blank section was cemented in series with the exception of the top blank section. The tool was pulled and the tailpipe below the run-in string shortened. A splined nipple was inserted in the string above the series cementing mandrel to permit proper positioning of the cement mandrel with respect to the splined nipple for the top blank section cement job. After cementing the top blank section, the run-in string was raised to position and the splined nipple and the bypass ports in the port coupling closed. The back pressure valve in the series cement collar takes the place of the clapper valve.

The only internal construction that requires drilling up is the key ring of the bypass port coupling and the rubber sleeve and retaining rings of the packoff coupling. This internal structure may be made of drillable aluminum or cast iron and is drilled up easily during the clean-out operations. This leaves the internal diameter of the couplings the same as the inside diameter of the liner.

Installations

One operator has made a total of 28 bypass installations as follows: Twenty 8⅝ in. by 6⅝ in:; two 7⅞ in. by 5 9/16 in.; one 9⅝ in. by 6⅝ in., and five 6⅝ in. by 4¾ in. Most of the liners were run with weight-setting packers. Twenty-four of the packers were equipped with lead seal rings; four with oil and heat resistant packing rings.

At the time of installation, there were no recorded failures in the mechanical operations of hanging the liner, cementing, and closing the bypass ports. There have been two failures of the liner seal and one of the bypass ports. Two of the failures, including that of the bypass ports, occurred in the 8⅝-in. by 6⅝-in. installations; the leak around the top of one was due to a failure of the lead seal. In both instances, the water string had failed, permitting the entry of a high head salt water immediately below and against the liner top. The third failure occurred in a 6⅝-in. by 4¾-in. oil and heat resistant ring-packing installation. This failure developed shortly after completion of the well, permitting the entry of high ratio production around the liner top.

The bulk of these installations was made between the first of 1939 and the latter part of 1940. During this period the field datum pressure ranged from 2000 lb. to 2800 lb. in the South Temblor. Four of these installations have been made in the North Temblor.

This equipment has proved to be mechanically sound. Through its use it has been possible to effect a positive seal around the liner top with a substantial saving in time and capital.

The author wishes to thank the Security Engineering Company, Incorporated, for supplying the illustrations for this article.

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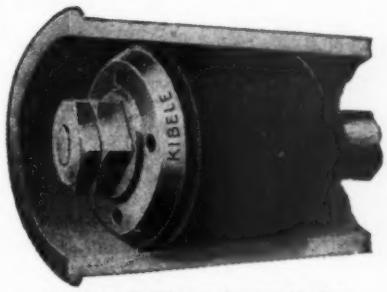

Double E Piston is made for every type of steam or power driven pump, and to fit any piston rod or pump liner. Composed of only three pieces, the body, packing ring, and follower plate, the Double E Piston is economical and will last indefinitely. The only wearable part is the packing ring, which can be purchased separately and installed easily and quickly on the original metal parts. These pistons have proved exceptionally successful in handling fluids containing abrasives. These Boiler Feed Pistons have proved to be the most economical pistons for oil fields over the years of service.

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When you can have all these advantages in a BAASH-ROSS HEXAGON KELLY

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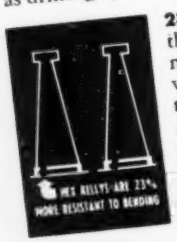
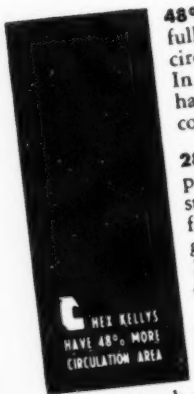
THERE are few pieces of oilfield equipment in which the difference between average and really outstanding performance is so marked as in the selection of a kelly. Because a kelly performs so many different functions—rotates the string, supports it, and is the "bottleneck" through which all circulation must pass—an advantage on just one or two points can make a big difference in rig performance. But compared with the conventional square kelly, the hex kelly out-performs not in just one or two ways, but on every point vital to better rig efficiency. . .

BETTER BALANCE: Because hex kellys are *machined* to exceptionally close tolerances from solid alloy steel stock, their dimensions are held to closer limits than is possible with the forged construction of square kellys. This, coupled with the unusually true, concentric bore and the accurate joint alignment, results in a highly uniform weight distribution . . . gives a smoother running, better-balanced kelly at all drilling speeds. This feature has proved to be particularly important for today's high rotational speeds . . . and as drilling speeds increase it will assume even greater significance.



23% MORE RESISTANT TO BENDING: One of the greatest difficulties in kelly operation is maintaining straightness. Generally, kellys bend while being swung back in the rat-hole . . . or through improper support when hauled or racked. In either case, the bend nearly always occurs across the flats. Hexagon kellys are 23.2%* more resistant to bending across the flats than are square kellys . . . and are also more resistant across the corners.



48% MORE CIRCULATION AREA: With today's full-hole pipe and high volume pumps, ample circulation area through the kelly is important. In addition to their greater strength, hex kellys have 48%* more circulation area than the comparable size of square kellys.

28% STRONGER IN TORQUE: Since a kelly is primarily a tool for rotating the entire drill string, its ability to transmit torque without failure is important. Because of its shape and greater cross-sectional area, the hexagon kelly is 28.6%* stronger in torque than a square kelly of comparable cross-corner dimensions.

1.8% GREATER TENSIONAL STRENGTH: Besides rotating the drill string, the kelly must also support the entire string . . . which makes tensional strength another important factor to consider. Because of its greater cross-sectional area, the hexagon kelly, size-for-size, is 1.8%* stronger in tension than the square kelly.

MAXIMUM ADAPTABILITY: In the widely varying operations of today the hex kelly is much superior to the square because it can be used under *all* drilling conditions—both for regular drilling and for pressure drilling—*without change!*

This means you not only save on your equipment inventories, for you can standardize all jobs to one type of kelly . . . but it also means far quicker changeover from regular to pressure drilling hook-up when emergencies threaten—*a vital advantage!*

★

*These figures are based on the widely-used 6" square kelly with 3½" bore vs. the 6⅛" hexagonal kelly with 4½" bore. Because it is the maximum dimension that governs the selection of a kelly size, the 6⅛" hexagonal (across-corner dimension 7¼") is actually ⅛" smaller in its limiting dimension than the 6" square kelly (across-corner dimension 7⅛"). In other comparable sizes, hex kellys offer proportionate advantages.

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Oil Industry Piston Rings

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☆ Proper manufacture, fitting, and maintenance assure maximum service

by Edward Stead

Chief Engineer, Koppers Company,
American Hammered Piston Ring Division

THE most important factor about piston rings, under present war conditions, is to obtain the longest possible length of service from the limited supply of rings. The length of service will depend on many factors: The material in the rings, their manufacture, inspection, handling, fitting, types of rings used, and the operating conditions in which they are used.

Material

Piston rings must have *resiliency* so they will spring out against a cylinder, *heat resistance* so they will retain their resiliency in service, and *good wearing properties* so they will wear slowly while causing equally slow sylinder wear with freedom from scoring. Spring steel has excellent resiliency but it lacks the desired wearing properties. Soft bearing metals have the wearing properties but lack the resiliency. Hard bronzes, which are quite good for both resiliency and wearing properties, can be produced but they lack heat stability and therefore require the support of some other metal when used in high temperature installations.

One material that can be made to incorporate all three of these properties to a sufficient degree to be practicable is cast iron and this material is therefore regularly used for piston rings. Needless to say, this type of cast iron is quite different from the more usual form used for heavy machine parts. It is closer grained and the graphite that gives it the good wearing properties is in much smaller particles.

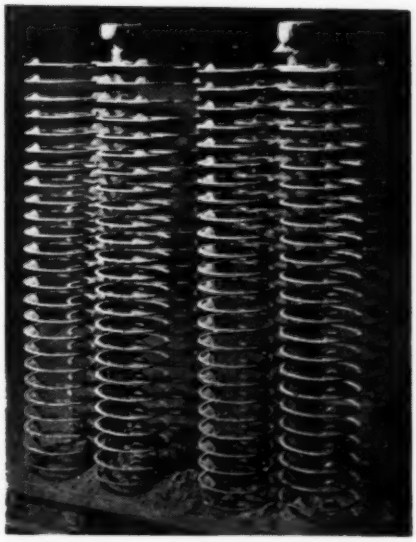

Fig. 1. A stack of individual castings

Infinite pains, expert skill, and highly specialized equipment are necessary for producing high quality piston ring castings with the proper wearing properties, the necessary resiliency, and freedom from casting defects. Piston rings are almost universally made from individual castings, each of which has a cross-section only slightly larger than that of the corresponding finished ring. A stack of these castings is shown in Fig. 1.

For certain types of service, as in some air starting valves on diesel engines, bronze piston rings are used. These are also made from individual castings and it is customary to use a high tin bronze to obtain the necessary resiliency. There are also piston rings with some parts made of bronze and other parts of cast iron. With these combination bronze and iron rings, even in installations where the lubrication at times may be insufficient for standard cast-iron piston rings, an extremely low rate of piston ring wear and cylinder wear can be obtained.

Manufacture

The manufacture of piston rings on a production basis requires a vast quantity of specialized jigs, fixtures, and tooling. Although the turning of the outside diameter is done on standard lathes and boring mills, several turning operations are used for producing the necessary accuracy of size and smoothness of finish. Also, on the turning operations, arbors for holding each size of ring are required in addition to various types of tooling for closing the piston rings and clamping them on the arbors. Standard milling machines equipped with fixtures for holding the piston

Fig. 2. Grinding the flat side of a piston ring

Fig. 3. Grooving the arbor full of slotted oil control rings

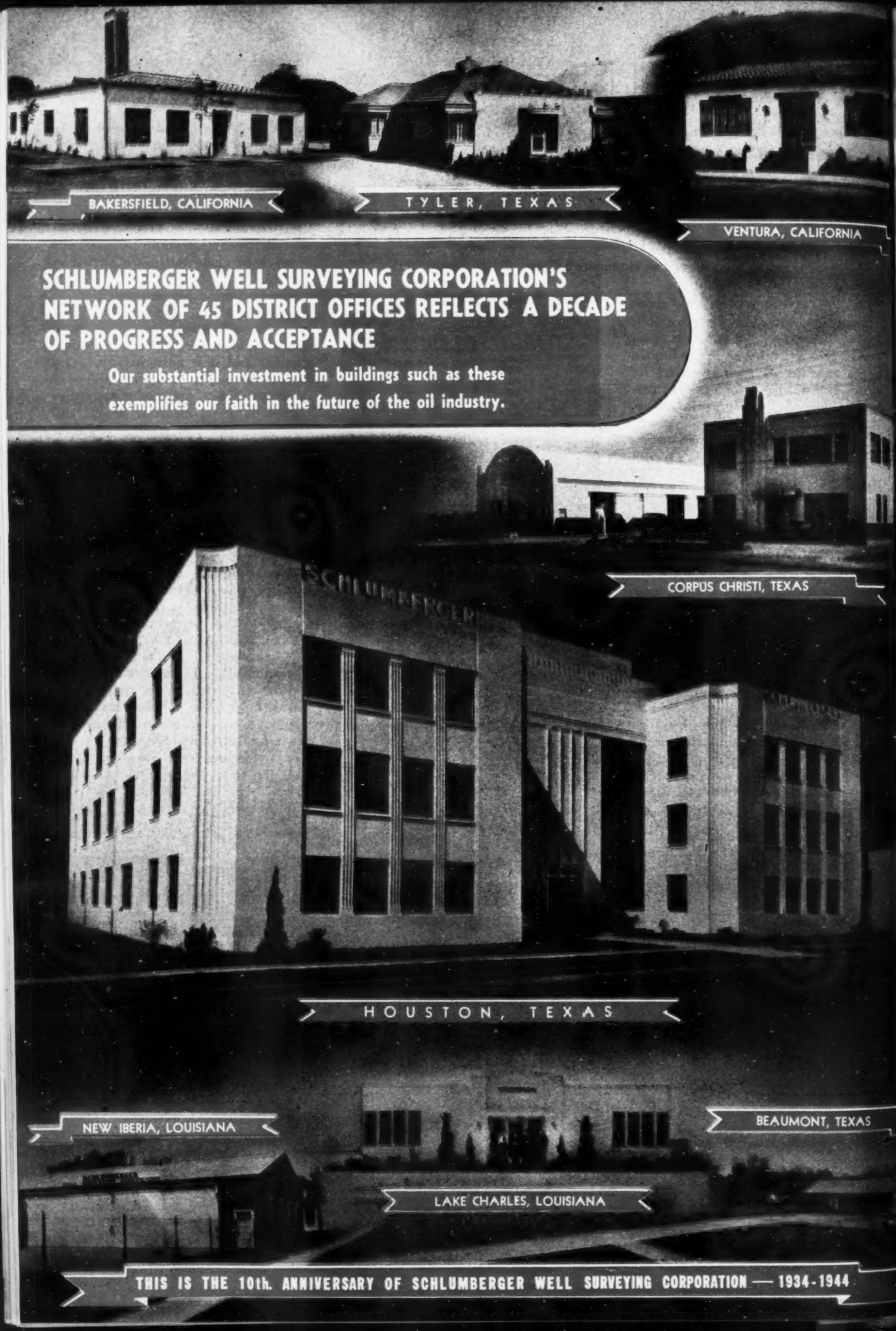
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Fig. 4. Milling the slots in oil control rings

rings are used for milling the joints.

The sides of piston rings are generally finished by grinding. One type of grinding is shown in Fig. 2. Lapping is employed for this operation on some of the small sizes whereas smooth turning is used on very large sizes, such as those used in the low pressure cylinders of steam engines. Regardless of the method, smoothness and flatness are vitally important because roughness, chatter, or a wavy condition will permit blowby across the sides of the rings. Flatness is also essential for proper conduction of heat from the piston through the rings to the cylinder wall.

Boring of piston rings is done on standard boring mills or on specially designed machines with individual fixtures for holding the various sizes.

Different manufacturers use different methods for producing tension in

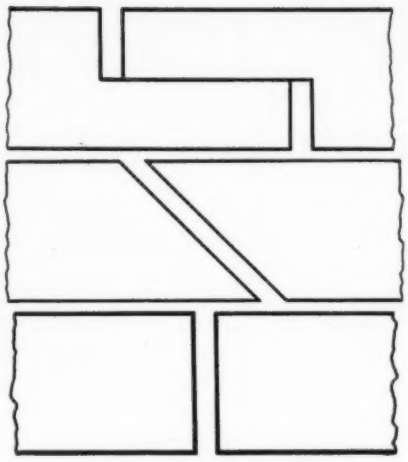

Fig. 7 (top). Step joint
Fig. 8 (center). Angle joint
Fig. 9 (bottom). Straight cut joint

piston rings. Some do this by milling out a relatively large section. This requires an out-of-round casting, which is closed and finish turned after being milled. Another method is heat treatment and a third one is hammering. With any of these, the two important points are: First, the uniformity of the distribution of the pressure around the circumference of each ring and, second, the proper amount of tension for the type of service in which the rings are to be used. Relatively heavy tension is required for the piston rings in 4-cycle internal-combustion engines whereas somewhat lighter tension should be used in 2-cycle engines. Piston rings for steam engines, air compressors, and refrigeration compressors have various amounts of tension, all of which are less than that required for rings of corresponding sizes in 4-cycle engines.

Numerous types of oil control rings are used and each requires its own particular tooling. The most usual features to be found on oil control rings are bevels, grooves, and slots. The beveling and grooving are normally done on lathes as shown in Fig. 3. In this operation, the rings are either mounted in multiple on arbors or held in individual fixtures depending upon the type and quantity of work involved. The slotting is usually performed on milling machines with the rings held on arbors while the slots are being milled. This is illustrated in Fig. 4.

Inspection

In order to maintain quality control, it is necessary to begin inspection in the foundry. In addition to the laboratory analysis and testing of the material, which perhaps does not properly come under the heading of inspection, there should be a visual and dimensional check of the castings before they leave the foundry. Similar checking is necessary on each operation throughout the machine shop. In addition to these, a final inspection on the finished product is essential. This involves careful measurement of all dimensions with micrometers or special gauges and a careful and thorough visual examination for pits, nicks, scratches, tool marks, or other imperfections. Piston rings also require the checking of additional features such as tension and light tightness as shown in Figs. 5 and 6. Tension is a measure of the force with which a piston ring springs outwardly against the

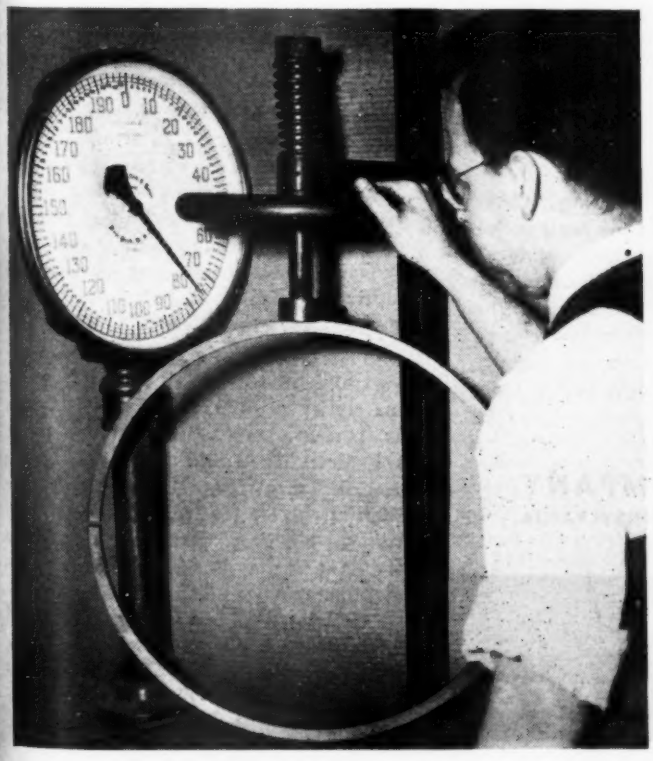

Fig. 5 (left). Measuring the tension of a piston ring

Fig. 6 (below). Placing a piston ring in a gauge preparatory to inspection for light tightness

cylinder and light tightness is a measure of the accuracy of the fit of the piston ring around the circumference of the cylinder.

Handling and Fitting

Whenever possible, it is advisable to keep piston rings in their original containers until they are ready to be used. If this is not possible, it is necessary to see that the rings are kept thoroughly coated with rust proofing. Also, each time they are handled, care must be taken to avoid damage. Merely knocking two piston rings together may nick them sufficiently to cause failure in operation.

Before piston rings are mounted on the pistons, each one should be placed in the smallest part of the bore of the cylinder in which it is to be used. If placed in this position by hand, a piston ring is likely to be tilted or twisted. Therefore, it should be moved into place by pushing the end of a piston against it so as to be sure that it is perpendicular to the axis of the cylinder. In this position the end clearance of the ring should be checked for correctness. Where fitting is necessary to obtain the correct end clearance, care should be taken to keep the ends flat and parallel and to renew any radius on the ends that might have been removed by filing.

The piston grooves should be inspected for flatness, cleanliness, and freedom from imperfections of any kind and the side clearance of the piston rings in the grooves should be measured accurately. If this clearance is insufficient, it should be increased by removing the necessary amount of metal from the sides of the rings. Carelessness in this work is likely to produce a rough and uneven surface that may cause the piston rings to fail in service. It is best to use a rotary surface grinder, if one is available, for removal of the excess metal from the sides of the rings in fitting them. If a grinder cannot be obtained, however, the rings may be rubbed down on a piece of fine emery cloth placed on a surface plate or other flat surface with extreme care being taken to keep the rings flat and smooth.

In deciding what end clearance and side clearance to use, it is generally best to follow the engine builder's recommendations. If these are not available, however, or if other suggestions are desired, reference may be made to the figures shown in Table 1. These figures are of a general nature and individual cases may require special clearances. For example, increased piston ring clearances may be necessary when higher output is required continually from an engine that operated successfully for years at lower loads. In this case, trouble might be experienced by the operator who continued to use the same clearances that formerly proved satisfactory. In connection with clearances, it should be remembered that it is always safer to use a little more clearance than may be absolutely necessary rather than to use a little less. No serious damage may be expected from slightly larger clearances whereas butting, breaking, and sticking of the piston rings, scoring of the cylinder, and various types of damage to the piston may be caused by insufficient piston ring clearances.

Types of Rings

A search of the patent files and advertising literature will reveal approximately as many types of piston rings as there are stars in the heavens above the earth. It would be impossible to describe many of these in an article such as this. A few types may be mentioned, however. First, in regard to the joint, it may be said that under normal operating conditions, relatively little difference in leakage is experienced with any of the usual joints—step, angle, or straight cut as illustrated in Figs. 7, 8, and 9. Therefore, in compressors, steam engines, and gasoline

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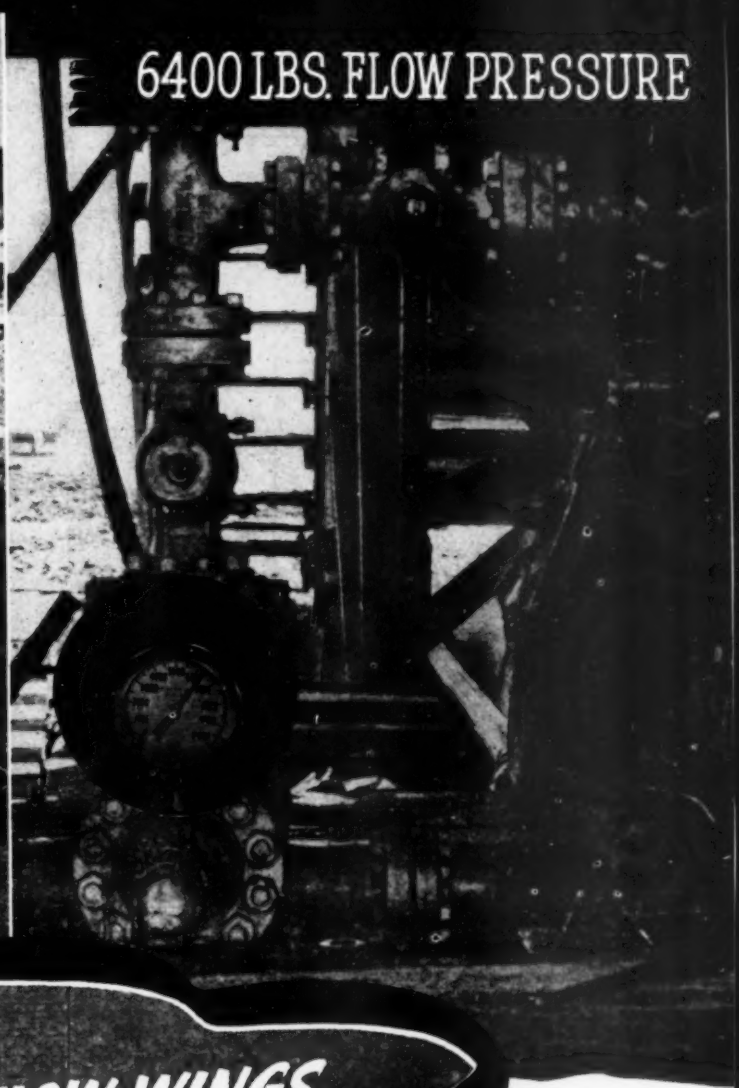

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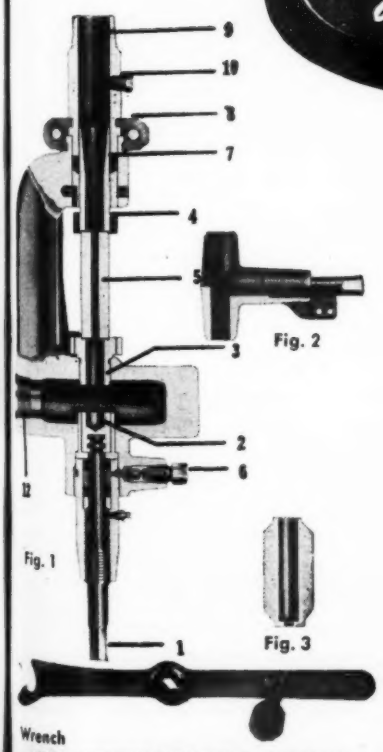

Fig. 1

Fig. 2

Fig. 3

CROSS-SECTION VIEW OF A CAMERON TYPE "D" FLOW WING *(Patented)*

The mechanical advantages, time-saving and economy features of Cameron Flow Wings are not limited to any given pressure service or to any make of Christmas tree. Like any other Christmas tree fitting, they may be incorporated in any manufacturer's surface control manifold. The above installation photographs illustrate the extreme pressure ranges in which Cameron Flow Wings are being used with complete satisfaction . . . in a simple, low pressure, screwed connection type manifold without conventional wing valves; and on the record high flow pressure well in a 10,000 lb. test all-flanged type manifold.

Operators who are not familiar with the mechanical design of Cameron Flow Wings are urged to study the cross-section view shown at left. Briefly, its operation is as follows: To change flow bean fit hexagon socket in wrench to valve stem (1) and close valve (2) against seat (3). Spanner part of wrench is then applied to clamp screw (4), and only two turns required to release flow bean (5). New bean is clamped in place by clamp screw and valve is then opened and well is back on production. Both valve stem and valve seat are faced with hard metal to resist cutting. Valve stem and bonnet are packed with plastic packing which may be replenished under pressure. Clamp screw is packed with an asbestos ring (7) which is tightened automatically as flow bean is clamped in place. Two-bolt union (8) obviates need for additional union in flow line. Note that downstream end of clamp screw is belled to reduce turbulence and cutting. Three types of flow beans are interchangeable: (1) "Proration" bean illustrated in flow wing; (2) adjustable flow bean, Figure 2; and (3) "production" type bean which consists of a body and renewable stellite orifice disc, Figure 3. All flow beans clamp in position as shown in Figure 1.

CAMERON IRON WORKS, INC.

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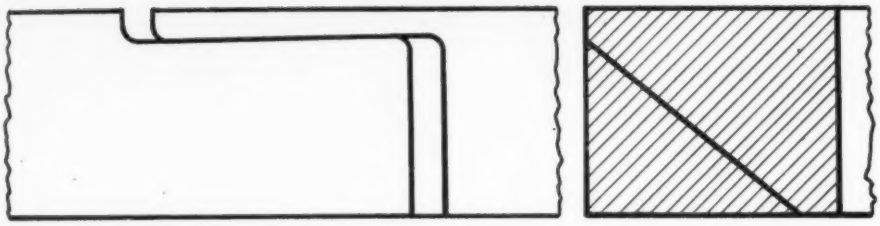

Fig. 10. Step seal joint

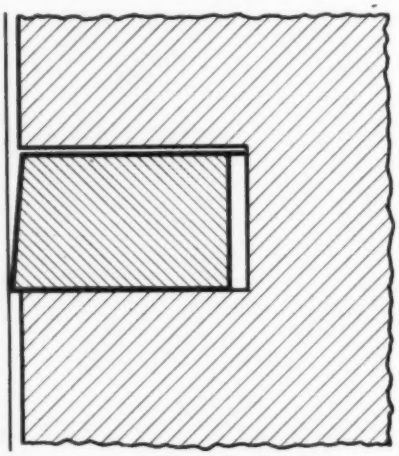

Fig. 11. Tapered compression ring

engines, it is seldom necessary to use any other type of joint. In some diesel engines, however, and especially in those in which there has been sufficient wear to cause the cylinders to be out-of-round or tapered, there are cases where it is advisable to use a one-piece piston ring with a sealing joint such as the step seal ring (Fig. 10) or a multiple-piece ring. When these are used, it is preferable to use them in the lower grooves with plain rings in the upper grooves because if sealing rings are used in the upper grooves, pressure trapped behind them may cause excessive wear in the upper part of the cylinder.

There are various modifications of the plain rings, which may either be used in the upper grooves, as mentioned, or in all compression ring grooves. The simplest of these is a cast-iron ring that has been chemically treated to have a thin coating—generally an oxide or phosphate—which promotes seating-in with a reduction in blowby and with the rapid development of a highly polished ring surface that tends to reduce the rate of wear and thus to prolong the life of the rings.

Another modified form of the plain ring is the tapered compression ring shown in Fig. 11. This type, which is best adapted to relatively narrow widths, has a slight taper of approximately 1° on the outside surface. The ring is installed with the bearing edge at the bottom so that during the seating-in period, the upper part of the ring obtains all the available lubrication. The narrow bearing edge has two important functions, first to enable the ring to seat-in quickly, even in a slightly out-of-round cylinder and, second, to scrape excess oil away from the combustion chamber during the seating-in period. The taper gradually wears off, developing a well polished ring surface that resists wear and increases the length of service obtained from a set of rings.

Another modification is the gold seal ring shown in Fig. 12. This is a plain cast-iron ring with a bronze insert projecting approximately 0.003 in. beyond the cast iron. This bronze conforms readily to a slightly out-of-round cylinder and permits the ring to seat quickly. While seating, the bronze burnishes the cylinder and thus reduces cylinder wear as well as ring wear. Multiple-piece bronze and iron rings give an even greater reduction of wear and they may also be constructed to form a joint seal. They thus tend to increase the length of life of the ring installation and to increase the efficiency of the engine in which they are installed.

In determining the type of oil ring to be used, one factor to be considered is the type of oil drainage that is provided, or that can be provided, on the piston. Center slotted rings should be used only when drainage holes are drilled in the back of the ring grooves as shown in Fig. 13. If drainage is provided only around the lower, outer edge of the groove, a beveled ring or a grooved ring or a beveled and grooved ring should be used as shown in Fig. 14. With either type, ample piston drainage is most essential in removing excess

TABLE I

Suggested piston ring clearances

Diameter, in.	4-cycle engines — Gasoline: Min. side clearance, in. — Compression: Top	Compression: Others	Oil	Min. end clearance for step and straight cut joints*	2-cycle engines — Gasoline: Min. side clearance, in. — Compression: Top	Compression: Others	Oil	Min. end clearance for step and straight cut joints*
Below 4¾	0.0015	0.001	0.001	0.005-in. x diam.	0.004	0.003	0.002	0.006-in. x diam.
4¾ to 5 15/16	0.002	0.0015	0.0015	0.005-in. x diam.	0.005	0.004	0.0025	0.006-in. x diam.
Over 5 15/16	0.004	0.003	0.002	0.005-in. x diam.	0.006	0.005	0.003	0.006-in. x diam.
	Diesel—uncooled pistons				Diesel—uncooled pistons			
	Minimum side clearance, in. — Compression: 2 top	Compression: Others	Oil	Min. end clearance for step and straight cut joints*	Minimum side clearance, in. — Compression: 2 top	Compression: Others	Oil	Min. end clearance for step and straight cut joints*
Below 6	0.004	0.003	0.002	0.006-in. x diam.	0.006	0.004	0.003	0.008-in. x diam.
6 to 12 15/16	0.006	0.004	0.003	0.006-in. x diam.	0.010	0.008	0.005	0.008-in. x diam.
Over 12 15/16	0.008	0.006	0.004	0.006-in. x diam.	0.012	0.010	0.006	0.008-in. x diam.
	Diesel—cooled pistons				Diesel—cooled pistons			
Below 6	0.003	0.002	0.0015	0.005-in. x diam.	0.005	0.003	0.0025	0.006-in. x diam.
6 to 12 15/16	0.005	0.003	0.0025	0.005-in. x diam.	0.009	0.007	0.0045	0.006-in. x diam.
Over 12 15/16	0.007	0.005	0.0035	0.005-in. x diam.	0.011	0.009	0.0055	0.006-in. x diam.
	Gas—uncooled pistons				Gas—uncooled pistons			
Below 6	0.006	0.005	0.003	0.006-in. x diam.	0.008	0.006	0.004	0.008-in. x diam.
6 to 12 15/16	0.008	0.006	0.004	0.006-in. x diam.	0.012	0.010	0.006	0.008-in. x diam.
Over 12 15/16	0.010	0.008	0.005	0.006-in. x diam.	0.014	0.012	0.007	0.008-in. x diam.
	Gas—cooled pistons				Gas—cooled pistons			
Below 6	0.005	0.004	0.0025	0.005-in. x diam.	0.007	0.005	0.0035	0.006-in. x diam.
6 to 12 15/16	0.007	0.005	0.0035	0.005-in. x diam.	0.011	0.009	0.0055	0.006-in. x diam.
Over 12 15/16	0.009	0.007	0.0045	0.005-in. x diam.	0.013	0.011	0.0065	0.006-in. x diam.

	Steam engines—saturated steam: Minimum side clearance, in.	Min. end clearance for step and straight cut joints*	Steam engines—superheated steam: Minimum side clearance, in.	Min. end clearance for step and straight cut joints*
Below 6	0.002	0.005-in. x diam.	0.003	0.008-in. x diam.
6 to 12 15/16	0.003	0.005-in. x diam.	0.005	0.008-in. x diam.
Over 12 15/16	0.004	0.005-in. x diam.	0.006	0.008-in. x diam.

Compressors

Diameter, in.	Min. side clearance, in.	Min. end clearance for step and straight cut joints*
Below 6	0.0015	0.003-in. x diam.
6 and over	0.0025	0.003-in. x diam.

*For 45° angle joints, multiply the figures in this column by 0.7.

Engineers' Piston Ring Handbook, published by Koppers Company, American Hammered Piston Ring Division

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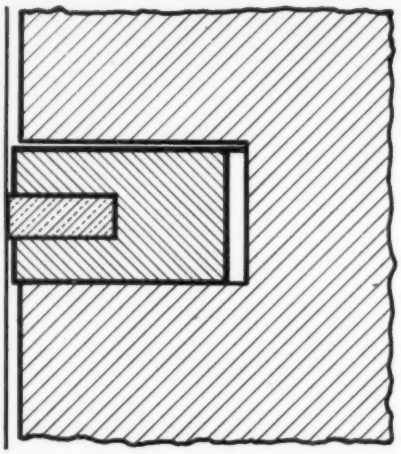

Fig. 12. Gold seal ring

oil and in avoiding clogging of the drains because insufficent drainage will cause the oil to accumulate and to harden under the influence of heat.

The effectiveness of an oil ring as a scraper depends largely upon the unit pressure of the ring on the cylinder. For a ring of any given size, this is determined by the tension and the width of cylinder bearing on the ring. Therefore, other things being equal, the oil rings with narrow bearing surfaces are the more effective scrapers. Any type of oil ring with a radius or bevel around

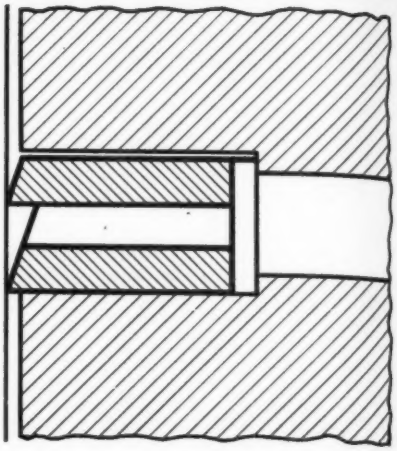

Fig. 13. Center slotted oil control ring

the upper edge tends to spread the oil over the cylinder on the upstroke and this helps to provide lubrication for the compression rings. Oil control is therefore a combination of oil spreading and oil scraping.

Operating Conditions

Anything that cannot be covered in any other way might come under the general heading "operating conditions." Operating engineers are only too familiar with these. Frequently, it seems that nothing can be done about them, especially under wartime conditions, but that is all the more reason for doing something about them whenever it can be done. Maintaining equipment in the best condition possible, providing periodic inspections so far as possible, watching the circulation of cooling water, and, most important and most obvious of all, maintaining proper lubrication, all these and other details are necessary to husband the present supply of available piston rings until after the war. High tensile iron and chromium plated rings now in use by the Armed Forces will then be available for industrial application.

☆ ☆ ☆

Fig. 14. Beveled and grooved oil control ring

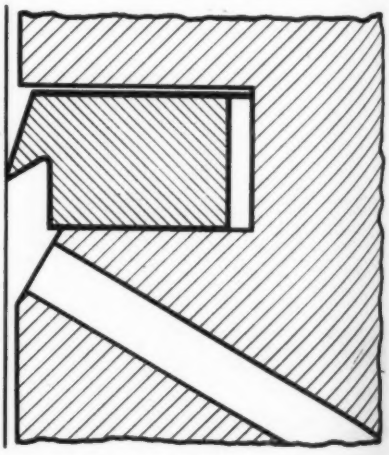

Fig. D322

The steel specifications and the process of manufacture of Spang Jars are the result of long intensive study, field performance, and productive experience. Each step in making the forging is carefully planned, executed, and thoroughly inspected. The heat treatment is done in modern specially built furnaces with heat recording instruments, under the supervision of personnel with long experience.

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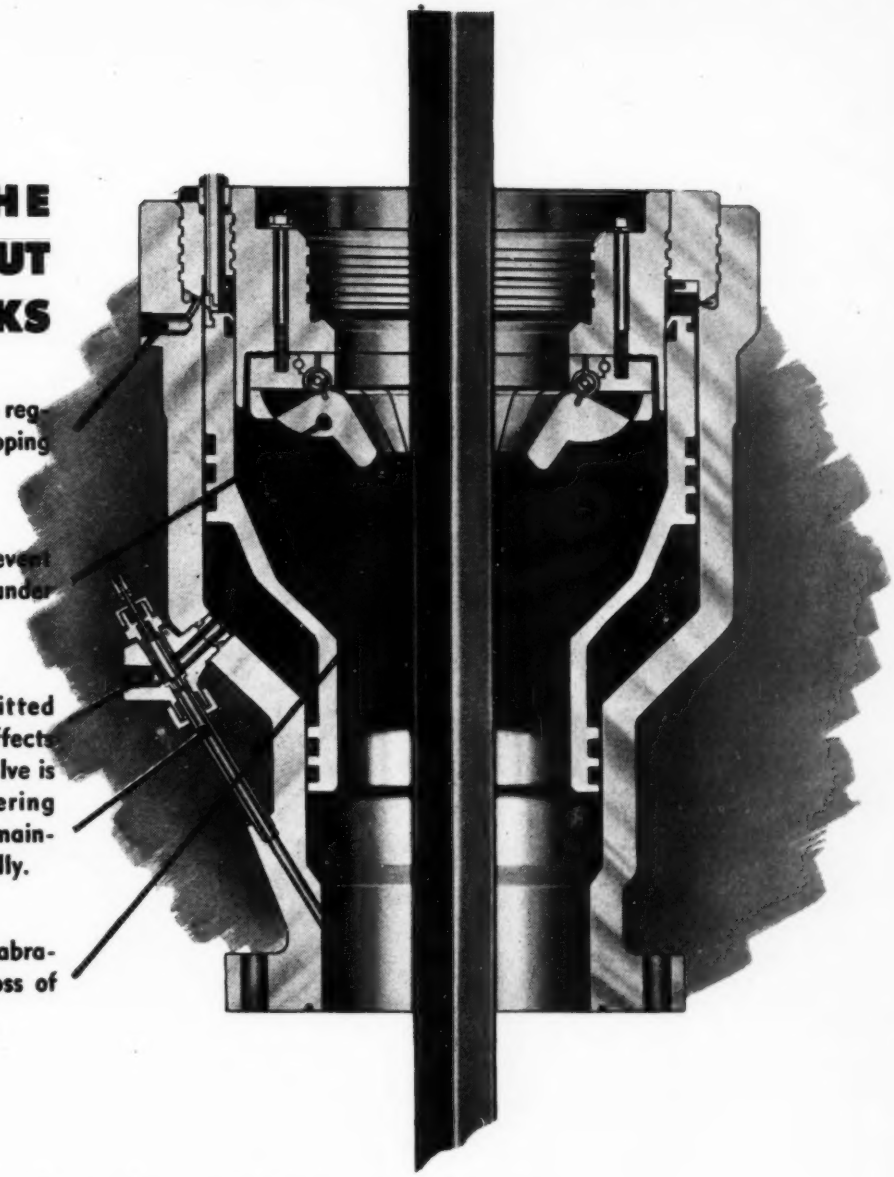
Heavy metal segments which prevent the extrusion of packer rubber under pressure.

3 INSTANT OPERATION
Fluid under pump pressure admitted here, raises contractor piston and effects pack-off instantly when control valve is opened. Pressure from well entering chamber through slanting passage maintains safe secure seal automatically.

4 POSITIVE PACK-OFF
Thick, resilient packer withstands abrasion, cutting and wear without loss of sealing efficiency.



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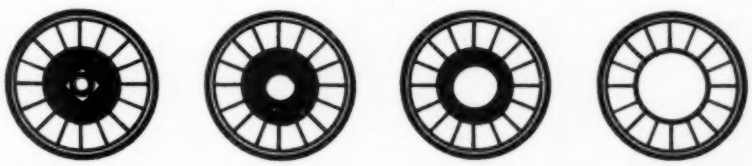
No. 4 size Type "R" Blowout Preventer, for use with 13⅜" casing, passes any tool used in 13⅜" pipe, and packs off around 4¼" square kelly, 4½" drill pipe and any size casing, without change or removal of inside parts or cellar connection.



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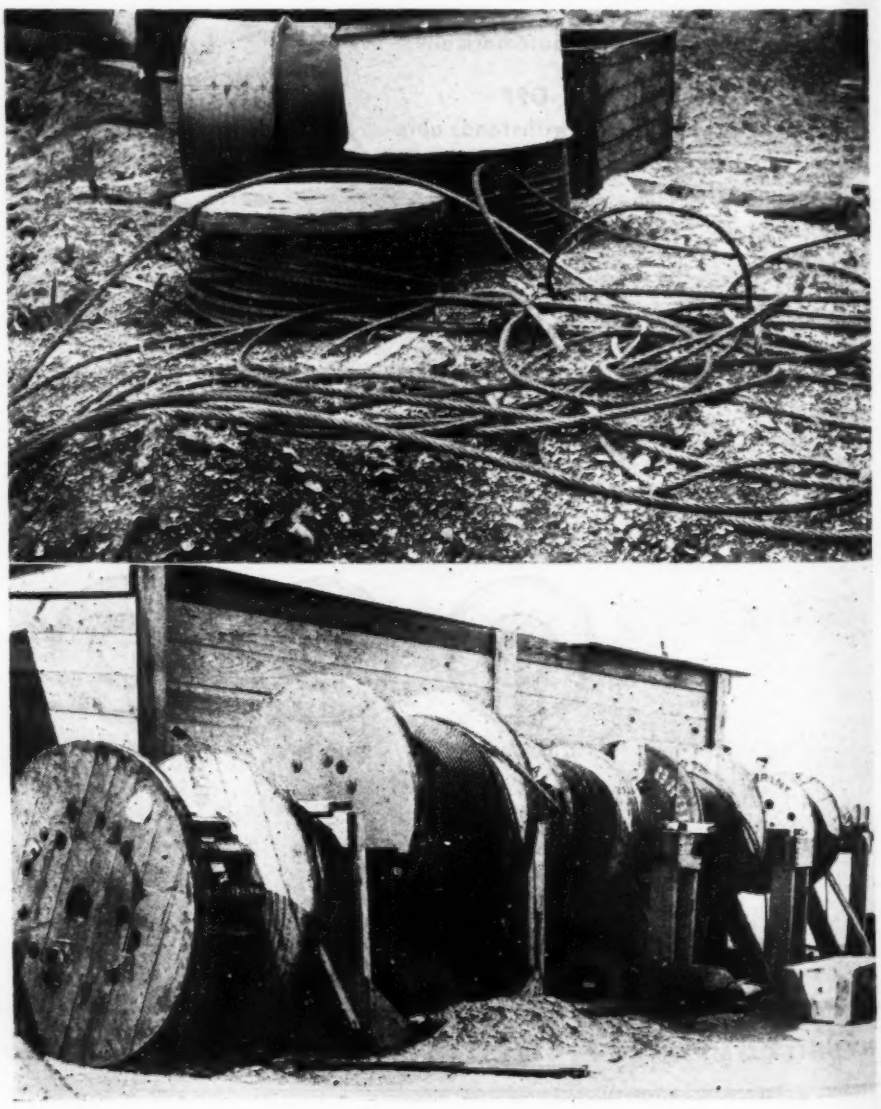
YOU would be much concerned if you knew some operator who bought a jeep, abused it terribly, then threw it away when a fourth of its usefulness was gone. You would cry "sabotage" because you know the soldiers on our 57 variety of fronts *need* jeeps. Well—pictured here is a comparable crime. This abused and discarded reel of wire rope probably cost about as much as jeep—and wire rope is sorely needed by our armed forces. This sort of criminal carelessness is akin to sabotage. It is a needless waste of valuable material—and, mister, that is a swell way to add more names to American casualty lists. Not impossibly the name you add might be your nephew, or the kid who lived up the street, or the lad who drove your grocer's delivery truck.

Manifestly, this is a reel of preformed wire rope because the ends have no seizing wire; despite the snarled condition of the rope there are relatively few dog-legs or kinks, and there are no broken crown wires porcupined to tear men's hands or clothing. Fully one-half (and probably more) of the rope's usefulness is yet on the reel, but even this has been rewound carelessly, then left in the dirt and mud to rust and destroy itself. The guy who left this rope in this condition should have been fired, then inducted into the infantry and given a winch truck to drive, if only to teach him the priceless value of steel cable. In this reel of discarded rope there are long lengths of perfectly good cable, well suited to boom line service, guy lines, hand rails, or any one of a dozen other applications.

In direct contrast to this type of Hitler-Tojo-aiding waste is the other picture in which is shown four reels of wire rope properly mounted above mud and grit and in such a way that needed lengths may be taken from the reels in straight, non-kinking manner. Here is an operator who thinks with his brain instead of his brawn. Even here, in this workmanlike storage of rope, it would be comparatively easy to build a roof extension from the adjacent shed and thus provide a rain shelter for the four reels. Wire rope is an intricate, precision-made machine having many interrelated parts. As such it deserves proper care and maintenance.

——— ☆ ☆ ☆ ———



Had the wire rope shown in the top photograph been properly cared for its useful life would have been greatly extended. In the bottom photograph the wire rope is properly mounted above mud and grit

After 7997 hours in service..

no measurable wear on

PORUS-KROME*

Photo courtesy of the New York Central System

In a test being made in a Diesel switching locomotive of the type shown above, no measurable wear was noted on PORUS-KROME cylinder surfacing after 7997 hours of operation . . . approximately one year in regular switching service.

This is another bit of evidence in the general experience that PORUS-KROME, applied to cylinders by the Van der Horst process, multiplies cylinder life 4 to 20 times. It makes the engine more reliable, too, because it eliminates a number of shut-downs for cylinder reboring or replacement . . . keeps the engine in operation many more hours of continuous running.

Whether it is used in engines of locomotives, or busses, or ships, or planes, or any other internal combustion engine, PORUS-KROME reduces to a minimum scoring, scuffing, ring feathering, and the risk of piston seizure. Let Van der Horst engineers show you how PORUS-KROME will lengthen the life of the cylinders in your engines, and lower the cylinder and ring maintenance cost.

* PORUS-KROME is pure chromium, applied by the Van der Horst process that produces pores to hold oil. It reduces wear, corrosion and scuffing, and greatly multiplies engine life when used on cylinder walls, or other bearing surfaces. May be obtained in Van der Horst plants or by license agreement.

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Petroleum Naphtha in Industry

☆ A discussion of the uses, tests, and properties of this important industrial material

by A. W. Trusty, Assistant Superintendent (Operating)
Premier Oil Refining Company of Texas, Operating Plancor 592

PETROLEUM naphtha has become an almost indispensable industrial material. Its use ranges from paint thinner to such lowly service as degreasing garbage. Probably the first use was in 1885 when it was introduced as a thinner for paint. For many years the naphtha was regarded as a cheap adulterant for turpentine and was called "turpentine substitute." Today turpentine makes up only a small percentage of paint thinners, and petroleum products are used more and more in paints, varnishes, and lacquers.

The first naphthas were roughly fractionated and the boiling ranges were wide with "tails" on each end. Modern super-fractionation produces naphthas of narrow boiling ranges; it is not uncommon to produce a naphtha with a 100°F. or even 60°F. boiling range. Also, commercially pure hydrocarbons such as pentane, hexane, cyclo-hexane, benzene, and toluene are produced and sold as solvent naphthas. A discussion of the uses, tests, and properties of petroleum naphthas is given.

Paint Naphtha

The general requirements for a satisfactory paint naphtha are:

1. Suitable volatility, permitting such an evaporation rate as to leave a durable film.
2. Suitable solvent power for the paint constitutents.
3. Stability in order not to go off color or develop an unpleasant odor.
4. Freedom from harmful or corrosive impurities such as certain types of sulphur compounds.

Paints are liquids containing solids in suspension. They are usually prepared by mixing finely ground pigments in a drying oil or varnish and then thinning with petroleum naphtha or turpentine. The drying oil usually is a mixture of raw and boiled linseed oil. The evaporation rate of the thinner largely governs the type of film formed on the painted surface.

Varnish is a solution of resins and a drier in a solvent or thinner, to which oils may be added. The solvents and thinners serve to distribute the film, forming constituents of the varnish on the surface to which the varnish is applied.

Nitro cellulose lacquer is a recent addition to the field of lacquers. The ingredients may be listed as follows:

1. Volatile ingredients that impart proper flow characteristics.
   a. Nitro cellulose and resin solvents such as ethyl, butyl and amyl acetates, and the corresponding alcohols.
   b. Diluents or non-solvents such as petroleum naphthas, benzol, toluol, and xylol.
2. Non-volatile ingredients or permanent film-forming constituents.
   a. Cellulose nitrate, commonly known as cellulose (made by treating cotton linters with concentrated sulphuric and nitric acids).
   b. A resin, natural or synthetic.
   c. A plasticizer or softener.
   d. A pigment or dye (if colored).

Rubber Manufacture

Petroleum naphtha is used in the rubber industry for:

1. The manufacture of tires, in which it is used to dampen the ply and tread stocks to effect better adhesion between the units of the tire during the building operation.
2. Rubber cements, which may be used as adhesives, or in the fabrication of hot water bottles, bathing caps, rubberized cloth, overshoes, and similar rubberized articles.

A typical use of naphtha is illustrated in the manufacture of dipped goods such as rubber gloves and toy balloons. A suitable form of wood, glass, or aluminum is dipped into a rubber or latex cement, lifted out, and the adhering solution allowed to dry. The process is repeated until the rubber coating reaches the desired thickness. After the dipping operation is complete, the article is then dried and vulcanized.

Petroleum naphtha should have the following characteristics for use in the rubber industry:

1. Satisfactory solvent or dispersing power for rubber.
2. Absence of chemical action on rubber.
3. Stability towards oxygen and moisture.
4. Minimum inflammability.
5. Suitable volatility — that is, it must not be too volatile for convenient use or so high boiling that the drying time is excessive.
6. Absence of objectionable odor.
7. Minimum of toxicity.

Rubber solvents containing cracked distillates or unsaturated hydrocarbons are considered undesirable. The unsaturates may react with certain chemicals, such as sulphur chloride, used in cold vulcanization. Oxidation of the unsaturates, with consequent formation of peroxides and gum, will result in an inferior rubber product. The greater stability of straight-run petroleum products is of more value than the slightly greater solubility (dispersive) power that cracked naphthas have for rubber.

Printing

Rotogravure printing is a photomechanical intaglio process, whereby reproductions of photographs, drawings, or type are made from a copper coated plate or cylinder upon which the design is etched below the surface instead of above the surface as in ordinary letterpress printing.

The cylinder or plate is covered with ink until all the etched cells are filled. The surface is then wiped clean with a suitable, flexible scraper. The design or type is transferred to the paper as it is pressed onto the plate. The ink is dried by passing the paper over a drying drum.

Petroleum naphtha plays an important part by making possible almost instant drying of the ink, thus permitting the high speed used in modern printing.

Stoddard Solvent

Typical dry cleaning practice today may be described as follows: The articles to be cleaned are put into cloth bags, which are placed in a large horizontal drum-type washer. The washer is partially filled with solvent to which oil soluble soaps may be added. At the end of about 20 minutes in the washer, which rotates first in one direction and then in the other, the bags are removed and the articles are placed in centrifuges, where most of the solvent is evaporated. Complete drying of the articles is then effected in a drying chamber. Any spots remaining are removed

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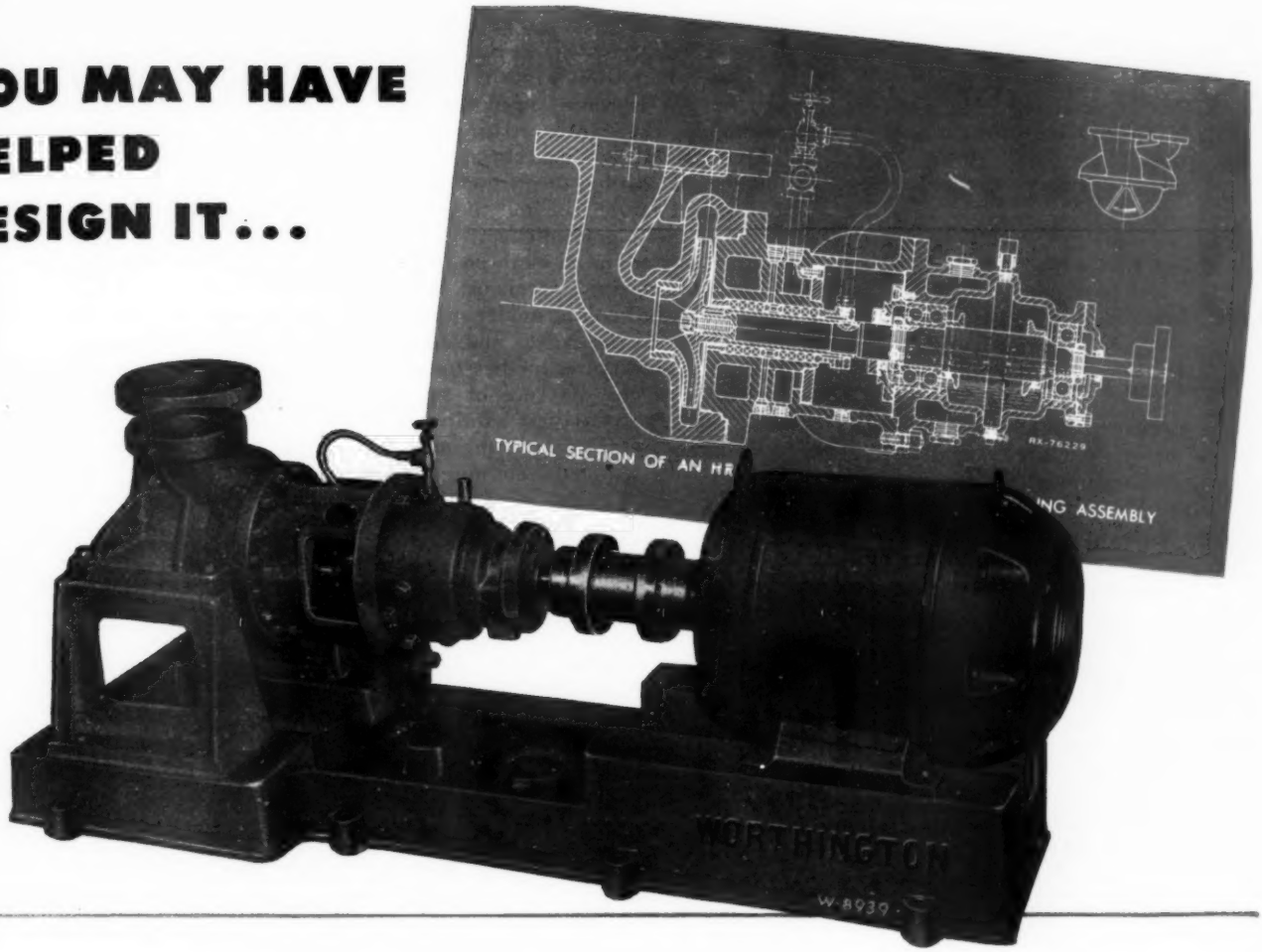

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1. Proper volatility. The naphtha should evaporate in a short time.
2. Safety.
3. Should not discolor or injure fabrics or dyes.
4. Non-toxic.
5. Chemically inert.
6. Odorless.
7. Non-corrosive to cleaning equipment.

Extraction

In perfume manufacture, the flower petals are extracted with cold solvent in a closed apparatus; the solvent then is separated by distillation leaving a perfumed wax. A low-boiling solvent is used, free from sulphur and unsaturated bodies, and with a low aromatic content.

The oil from oil-bearing seeds, such as cottonseed, rape, linseed, and castor, is removed from the seeds either by pressure in a hydraulic press or by extraction in a suitable solvent, or a combination of the two methods. Linseed, for example, contains about 36 per cent oil, and hot expression removes about 26 per cent, leaving 10 per cent to be extracted by solvent.

Bones and other animal refuse are the raw material used for the manufacture of animal glue, bone manures, and bone fertilizer. The bones are crushed and are then extracted in a suitable steam-heated extractor with a solvent naphtha. The naphtha removes the oil and grease, which is used in candle or soap manufacture. Naphtha is used to recover grease from garbage, to degrease hides, and to extract grease from animal hairs in the manufacture of hair cloth.

Miscellaneous Uses

Petroleum naphthas have an imposing list of uses in modern industrial processes.

Natural and artificial leather: Patent leather is made by coating natural leather with either a varnish or nitrocellulose lacquer. The leather must be thoroughly degreased before the coating is applied. Petroleum naphtha is used both for the degreasing operation and for thinning the varnish or lacquer.

Artificial leather is made by applying a number of coatings of nitro-cellulose lacquer to a fabric base and then embossing to give a grained effect.

Other uses are in oil-cloth coatings; textile printing dyes; furniture, automobile, and shoe polish; mildew-proofing compounds for canvas and duck; linoleum manufacture; binders for asbestos in the manufacture of brake lining; rust preventives; sandpaper bindings; waterproofing compounds and insulating materials; cleaning and degreasing metal parts; soap, insecticides, and wood preservatives.

Laboratory Interpretations

A.P.I. gravity. Gravity is of little value as an index of the quality or usefulness of a petroleum naphtha. The test is of value chiefly for computing weights and making volume corrections.

Flashpoint. The flashpoint of a naphtha is usually determined in the Tag closed tester. In this method, the naphtha is placed in a closed cup and heat is transmitted to it by a water bath. A test flame is introduced into the vapor space of the cup at each 1°F. rise in temperature until a distinct flash in the cup is observed. The temperature recorded at that point is the flashpoint of the naphtha.

Fire hazard is the principal consideration in determining the flashpoint of a naphtha, and this test is generally recognized as the best index of the probability of ignition.

Distillation. This is the American Society for Testing Materials standard test for distillation of light petroleum products. One hundred cu. cm. of the naphtha are distilled from a special flask through a condenser and received into a graduated receiving cylinder. When the first drop of condensate falls into the receiver, the temperature is recorded as the initial boiling point, and the highest temperature observed during the test, usually reached after the bottom of the flask has become dry, is recorded as the endpoint, or final boiling point. Also, the temperature is read when each 10 cu. cm. (which is 10 per cent by volume of the original naphtha charge) is recovered in the graduated receiver. The portion of naphtha remaining undistilled in the flask at the end of the distillation test is termed the residue.

The distillation test is one of the most important tests used on petroleum naphthas, because volatility and drying rate are directly connected with the boiling range.

Color. The Saybolt chromometer is used to determine the color of petroleum naphtha. A depth of a column of naphtha necessary to match a glass standard-color disk is measured, and a numerical color number assigned ranging from 30 (colorless) to minus 16 (straw).

Color is of definite importance in the case of naphtha for dry cleaning because it must not discolor fabrics. It is also important in those cases where the naptha is to be used as a diluent for colorless products.

Doctor. The "doctor test" is a sensitive test for hydrogen sulphide and mercaptans, sulphur compounds that may contribute odor to the naphtha. This test gives no indication of the total sulphur content, nor of the exact corrosiveness of the naphtha. The test is made by shaking the naphtha to be tested with a solution of sodium plumbite (litharge dissolved in caustic soda). After shaking vigorously, a pinch of sulphur is added and the mixture shaken again. If the naphtha is discolored, or if the yellow color of the sulphur film is noticeably masked, the sample is reported "positive" or "sour". If both the naphtha and sulphur remain unchanged in color, the sample is reported "negative" or "sweet."

Corrosion. The copper strip test shows the presence of corrosive sulphur compounds that might discolor paints or corrode metal surfaces. A copper strip is immersed in the naphtha and

TABLE I

Specifications for standard aliphatic and naphthenic solvents[3]

Solvent number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A.P.I. gravity	70.5	70-73	64.0	62.0	62.0	55-61	55-60	45-53	47-54	61-43	46-51	50.0	43-48	43.0
ASTM distillation, °F. initial B.P.	140	105	170	205	200	215-230	205-210	290	305	310	325	360	340-370	370
50 per cent over	175	175-185	200	210	220	250	255-265	305	345	340	350	380	390-410	430
90 per cent over	195	220	220	220	240	270	310-315	315-330	370	370	370	400	425-435	475
Endpoint	210	250-265	240	235	265	295-305	370-375	330-350	400	400	400	410	460	510
Kauri-butanol[1]	33.5	34.0	37.5	38.0	38.0	35-39	35-39	36-47	31-40	42-46	34-36	31.0	29-37	32.0
Aniline point[2]	135	135	128	125	125	125-135	125-135	110-135	125-150	114-120	140	151	135-160	150
Nitrocellulose diln. ratio[3]	1,30	....	1.35	1.40	1.40	1.30	....	....	....	....	....	....	....	....
Flashpoint[4], °F	....	....	....	....	....	....	....	85	103	105	115	141	130-150	150

1=light lacquer diluent, benzene replacement.
2=rubber solvent.
3=intermediate lacquer diluent.
4=special extraction solvent.
5=heavy lacquer diluent, toluene replacement.
6=V.M. & P. (close cut).
7=V.M. & P. (long cut).
8=xylene replacement.
9=mineral spirits.
10=naphthenic mineral spirits.
11=high-flash mineral spirits.
12=high-flash (140°F.) dry cleaning solvent and paint thinner.
13=flat-finish thinner.
14=slow-dry thinner.

[1]Using Stewart Research Lab. standardized and certified kauri butanol solution.
[2]Equal volume method. A.S.T.M. D611-41T.
[3]At 10 per cent final concentration.
[4]Tag closed cup method, A.S.T.M. D56-36.

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held at a temperature of 122°F. for 3 hr. At the end of the test the strip must not show more than a slight discoloration.

Another more severe test is made by holding the naphtha at its boiling point for 30 min. with a copper strip immersed in the liquid. Discoloration of the strip is caused by compounds that are present or that decompose at the temperature employed to produce corrosive compounds.

Kauri butanol number. This is one of the most widely used tests in the paint and varnish industries. The purpose of the test is to determine solvent power; the higher the kauri butanol number the greater the solvent power for certain gums or resins.

Twenty grams of a clear solution of kauri gum in butyl alcohol are weighed into a flask. With the solution maintained at 77°F., the naphtha is added slowly until 10-point type on white paper under the flask is blurred and no longer legible. The number of cu. cm. of the naphtha added to the gum solution is the kauri butanol number.

For highest accuracy, the solution should be standardized. Determine the n-heptane and benzene equivalents of the standard kauri gum solution. Plot these values against solvent power using the kauri butanol value of heptane as 0 per cent and that of benzene as 100 per cent solvent power. Draw a straight line between these two points, from which the solvent power corresponding to any kauri butanol value can be directly read. (See table in column to left.)

Solvent power of petroleum hydrocarbons[1]

Hydrocarbon	Formula	No. of carbon atoms	Solvent power
Paraffins			
N-pentane	C_5H_{12}	5	33.8
Iso-pentane	C_5H_{12}	5	28.8
N-hexane	C_6H_{14}	6	26.5
2-Methyl pentane	C_6H_{14}	6	25.0
N-heptane	C_7H_{16}	7	25.4
N-octane	C_8H_{18}	8	24.5
Dodecane	$C_{12}H_{26}$	12	18.7
N-hexadecane	$C_{16}H_{34}$	16	14.3
Olefins			
Hexene	C_6H_{12}	6	33.6
Octylene	C_8H_{16}	8	36.5
Diisobutylene	C_8H_{16}	8	35.2
Triisobutylene	$C_{12}H_{24}$	12	32.3
Naphthenes			
Cyclo-hexane	C_6H_{12}	6	54.3
Methyl cyclohexane	$C_6H_{11}CH_3$	7	50.5
Octadecylcyclohexane	$C_6H_{11}C_{18}H_{37}$	24	24.2
Hepta decyl-n-butyl-cyclohexylmethane	$C_6H_{11}CHC_4H_9C_{17}H_{35}$	28	19.8
Aromatics			
Benzene	C_6H_6	6	100
Toluene	$C_6H_5CH_3$	7	93.7
O-xylene	$C_6H_4(CH_3)_2$	8	99.0
M-xylene	$C_6H_4(CH_3)_2$	8	89.6
P-xylene	$C_6H_4(CH_3)_2$	8	82.5
Ethyl benzene	$C_6H_5C_2H_5$	8	85.7
Cumene	$C_6H_5CH(CH_3)_3$	9	75.7
Mesitylene	1,3,5 $C_6H_3(CH_3)_3$	9	85.9
Pseudocumene	1,2,4 $C_6H_3(CH_3)_3$	9	105.5
N-butyl benzene	$C_6H_5C_4H_9$	10	68.7
Octadecyl benzene	$C_6H_5C_{18}H_{37}$	24	37.0

These data show that the aromatic hydrocarbons have the highest solvency values, the paraffins have the lowest, and the olefins and naphthenes are intermediate.

Dilution Ratio

A solution of nitrocellulose containing an active solvent will tolerate a definite quantity of non-solvent, and the maximum amount is called the critical point. A further addition of non-solvent will cause precipitation, or jelling, of the nitrocellulose. The butyl acetate dilution ratio test shows the approximate tolerance of nitrocellulose solutions for petroleum naphthas employed as diluents in the formulation of lacquers and artificial leather dopes.

A sample of the naphtha is slowly added to a solution of low viscosity nitrocellulose in butyl acetate until precipitation of the "cotton" occurs. The ratio of the volume of added naphtha to the volume of the original nitrocellulose solution is the butyl acetate dilution ratio.

In the formulation of nitrocellulose lacquers to obtain optimum spreading and covering properties when using "½ second nitrocellulose cotton without danger of cotton blush," the maximum amount of petroleum naphtha that can be used with various solvents is shown. The petroleum naphtha used had a boiling range of 176-266°F. For example acetone used as a solvent will tolerate up to 0.7 times its volume of petroleum naphtha as a diluent.

Comparative solvency of some paint and varnish dissolvents as measured by the kauri-butanol test:

	Kauri-butanol No.
Turpentine	82.1
Dipentene	105.1
Pine oil	infinite
Gum turpentine	56
Steam distilled turpentine	58
Toluene	106.7
Xylene	88.2
Solvent naphtha	85.3
Petroleum naphtha	36.0

Solvent	Dilution ratio
Acetone	0.7
Amyl acetate	1.5
Ethyl acetate	1.1
Ethyl lactate	0.7
Isobutyl acetate	1.1
Isopropyl acetate	1.3
Methanol (anhydrous)	0.3

Close-Cut Solvents

Certain close-cut solvents are now fractionated from natural gasoline. In the manufacture of these commercially pure hydrocarbons, columns of 150 or more plates are used and a reflux ratio of 100 to 1 is employed. It has been found for solvent use that the narrower the boiling range, the more even the evaporation curve and the better the evaporation control will be. Some typical petroleum solvents are shown.

Solvent	Boiling range, °F.
Technical n-hexane	155.3—156.3
Commercial n-hexane	152 —157
Technical n-heptane	208.6—209.6
Commercial heptane	198 —210
Technical cyclopentane	120.2—121.2
Technical methylcyclopentane	160.7—161.7

TABLE 2

General uses of petroleum solvents

Solvent number*	Paints	Varnishes	Lacquers	Flat finishes	Rubber cements and adhesives	Rubber dip goods	Rubber tires and war materials	Rosin extraction	Castor oil extraction	Fat extraction	Dry cleaning	Rust inhibitors	Textile, flame, rot, waterproofing	Textile and pigment printing	Floor coverings	Brake linings	Artificial leather	Rotogravure inks	Adhesive tapes	Leather degreasing	Waxes	Shade cloth	Metal and machine cleaning
1			X		X		X		X	X			X	X		X	X	X	X	X			
2	X		X		X		X		X	X						X		X	X	X			
3			X		X		X		X	X			X				X	X	X	X			
4								X															
5			X		X		X	X	X	X			X	X			X	X	X	X			
6	X	X	X		X	X	X	X	X	X	X		X		X	X	X	X	X	X	X	X	X
7	X	X			X	X			X	X			X		X	X				X	X	X	X
8	X	X	X		X	X				X	X	X	X	X	X	X		X		X	X		X
9	X	X		X								X	X	X	X	X		X		X	X		X
10	X	X		X								X	X	X	X	X		X					X
11	X	X		X							X	X	X	X	X	X							X
12	X	X		X								X	X	X							X		
13	X	X		X																			
14	X	X		X																			

*Key to solvent numbers is given at bottom of Table 1.

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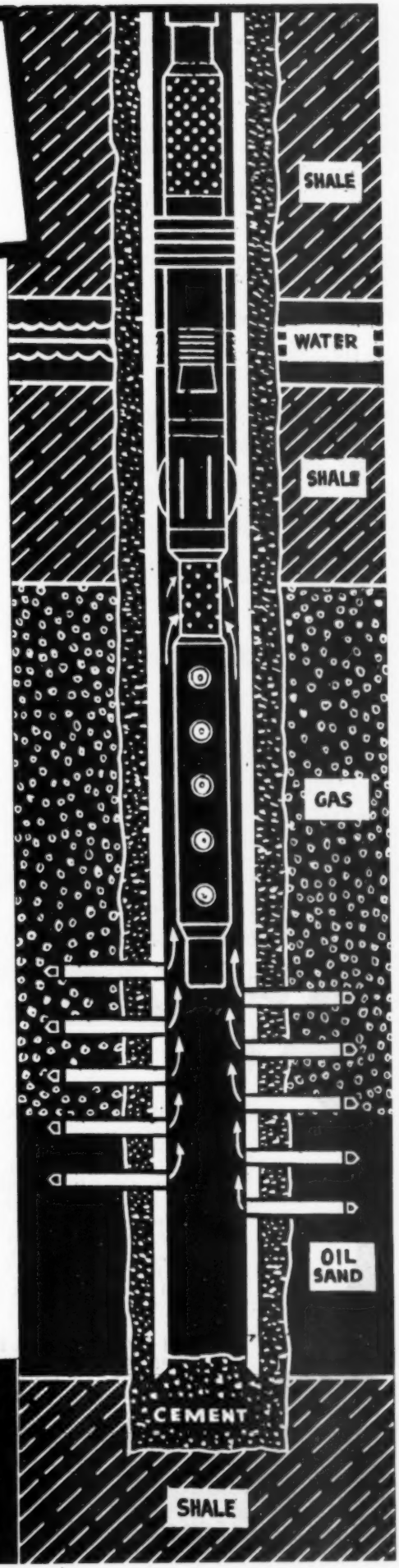

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ODESSA, TEXAS			SACRAMENTO, CALIF.

Normal hexane is used in the extractions of soybean, cocoa bean, linseed oil foots, corn oil, peanut oil, and essential oils; in cleaning precision mechanisms; in tire rubber, rubber cement, and shoe manufacturing; in flameproofing, artificial leather finishes, cellophane and marking tapes. Commercial heptane is used for the extraction of castor oil, cocoa beans, peanut oils, corn oil, tankage, and grease; for intaglio inks, and cellophane and marking tapes, and for tire and rubber manufacture.

Coal Tar Solvents

The hydrocarbon class of coal tar solvents includes benzene, cyclohexane, toluene, methylcyclohexane, xylenes, isopropylbenzene, decalin, tetralin, amylnaphthalenes, and mixtures of these compounds. Formerly the source of coal tar solvents was solely from the distillation of coal, but recently several of these hydrocarbons have been produced from petroleum.

Benzene, commercially called benzol, has a boiling point of 176°F. It is insoluble in water but soluble in most common organic compounds. It is used as a diluent in quick-drying lacquers, in paint and varnish removers, in rubber cements, etc. The vapors of benzene are very toxic. Even small amounts of the vapors breathed over a period deplete the blood in both white and red corpuscles and greatly lower the resistance to infection.

Toluene boils at 231°F. Because solutions of nitrocellulose and of cellulose esters can be diluted with large amounts of toluene without causing precipitation, toluene finds extensive use as a diluent for nitrocellulose or cellulose ester lacquers. Toluene is a solvent for many natural resins, such as dammar, copal ester, and mastic, but it does not dissolve shellac or copals. It is a good solvent for most synthetic resins and an excellent solvent for chlorinated rubber. Toluene is not so dangerously toxic as is benzene.

Xylenes, commonly called xylols, are solvents for ester gum, copal esters, dammar, and mastic, but do not dissolve copals or shellac. The xylols have a flashpoint of 80°F. and boiling ranges of 280 to 289°F.

Tetralin is made by the hydrogenation of naphthalene. It boils at 392°F. It dissolves a wide range of oils, gums, resins, and waxes. It is used in detergents and soaps for textile purposes.

The coal tar naphthas are mixtures of higher boiling aromatic hydrocarbons. Some of the applications are for raw wool scouring operations, bronzing liquids, baking enamels, metal protective coatings, marine finishes, soap manufacture, dry cleaning solvents, and thinner for insulating varnishes.

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☆ ☆ ☆

Technicians Needed

The war-born necessity of a token force of oil specialists supplying millions of fighting men with a flood of petroleum products for war faces serious impairment, Chairman William R. Boyd, Jr., of the Petroleum Industry War Council declared, should additional drain on trained technicians from America's oil ranks prevail.

Induced principally by demands of draft boards for military manpower, coupled with lack of college graduates in specialized sciences, the petroleum industry is finding it increasingly difficult to keep pace with war requirements because of decreased professional personnel, the PIWC chairman declared.

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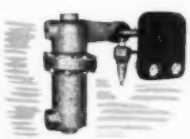

HANLON-WATERS TYPE 850 LEVEL CONTROLLER. This controller, first introduced 5 years ago, is still LEADER in the control of liquids of any gravity, temperature or working pressure. Applications: Control of liquid level. To actuate remote recording gauges. Duo-gravity control for wide range applications.

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2 *maintain constant pressure on superfractionating columns, by controlling overhead vapors.*

3 *regulate the volume of fluid flow from reboilers and reflux make accumulators, thus maintaining liquid levels at exact process requirements.*

4 *regulate pressure of fuel gas to cracking furnaces, reboiler and reheating furnaces and other heaters used in refinery operations.*

5 *control volume of regeneration gases to catalyst beds.*

6 *maintain constant temperature of vapors and liquid leaving cracking furnace coil, by controlling volume of fuel gas to cracking furnace burners.*

7 *maintain constant steam pressures in boilers, by controlling flow of fuel gas to boiler burners.*

8 *maintain constant feed-water line pressure to boiler feed-water regulators, by controlling steam to boiler feed pumps.*

Economic Factors of the Corrosion Problem*

☆ A study of the depreciation of pipe line systems due to corrosion

by H. C. Gear
Lone Star Gas Company

THE economic factors of the corrosion problem are so closely associated with the problem of depreciation that they bear out the relationship of cause and effect to the extent that the two are practically synonymous.

In this connection depreciation may be generally defined as the liability for the cost of the ultimate renewal or retirement of the units of a group installation which has accrued up to a given date, plus the capital value of any loss in service capacity that has taken place despite the effect of renewals or repairs. It is manifest that the liquidation of the liability for future renewals will not be required until after the elapse of a period of time measured by the difference between the service age of the group at the date of investigation and the service life of the unit retired at the date of renewal. Therefore, the amount of this accrued liability must be expressed in terms of the present worth of the unit value (one dollar) payable at the estimated date of renewal. This latter statement applies with equal force to the anticipated cost of repairs and to the rate of accrual of the capital loss represented by loss in service capacity.

The particular phase of depreciation treated in this discussion is that relating to the diminution in service life due to the selective and concentrated attack of corrosion causing mortalities of units of pipe and the need for repairs and replacements. This circumstance leads to a consideration of the behavior of a group of like property units installed at a given date and to the manner of interpreting this behavior from the standpoint of the investigator. Experience has shown that the renewal of property units of a group installation in a like environment will follow some definite trend or pattern with the rate of renewal reaching the maximum at the average life of the group. For the purpose of clarifying the discussion the ratio of the units renewed at each age interval to the total units installed is termed "mortality frequency" and the percentage of the group remaining in service at each age interval is termed "mortality survivors." (See Fig. 1). The average life of the group occurs at the age interval corresponding to the "service age" when 50 per cent of the units have been retired. (See appendix for definitions).

If the group installation has passed through a complete life cycle, that is, all the original units have been replaced, a condition which, unfortunately, is rarely if ever encountered by the investigator, basic data are then available with which to fix the "mortality curve" of the original units. If no renewals are made as the mortalities occur the distribution of the failures with respect to age intervals will fix the "mortality frequency distribution curve." However, if renewals are made concurrent with mortalities the total number of renewals will be greater than the mortality frequency rate of original units due to the fact that each of the replacement units will start a new life cycle similar to that experienced by the original units. The summation of the replacement of original units and the replacement of replacement units occurring at the same age intervals will, of course, exceed the mortality frequency indicated by the life cycle of the original units. A frequency distribution curve of this type will tend to oscillate above and below a normal rate with the amplitude of the oscillations diminishing as the age intervals increase until the total annual renewal rate will approach a constant value fixed by the average life of the group.

All annual renewal curves calculated by Kurtz[1], Winfrey[2], Marston and Agg[3] are developed upon the assumption that each renewal will follow the mortality characteristics of the original group. In other words, each renewal is treated as an original group installation which will have the same mortality frequency characteristics as the original group installation. While this method is correct when applied to specific property units and conforms to the above discussion, it nevertheless fails to develop sound results when applied to a group installation of units such as joints of steel pipe.

If the pattern of the mortality fre-

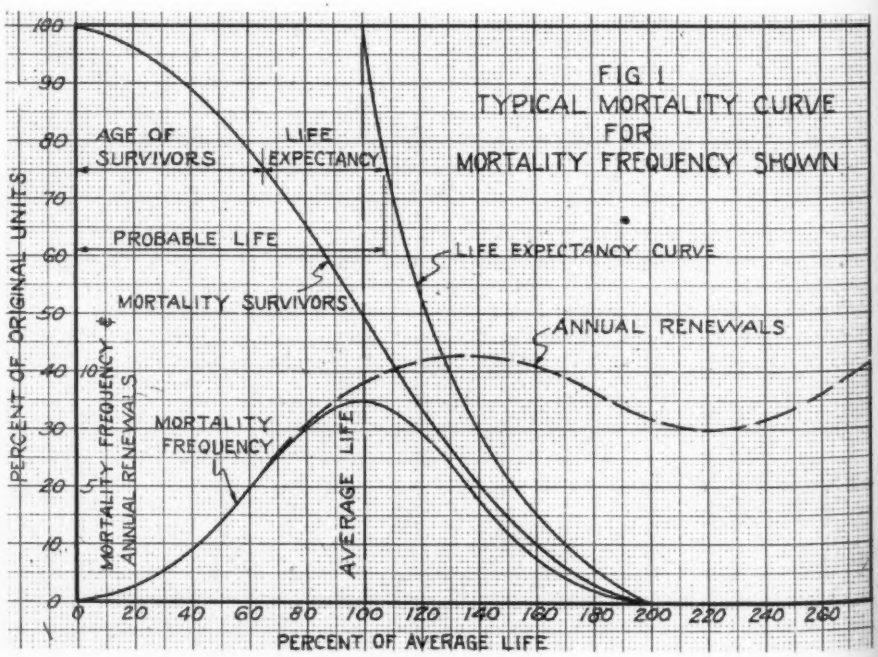
FIG 1
TYPICAL MORTALITY CURVE FOR MORTALITY FREQUENCY SHOWN
AGE OF SURVIVORS
LIFE EXPECTANCY
PROBABLE LIFE
LIFE EXPECTANCY CURVE
MORTALITY SURVIVORS
ANNUAL RENEWALS
MORTALITY FREQUENCY
AVERAGE LIFE
MORTALITY FREQUENCY & ANNUAL RENEWALS
PERCENT OF ORIGINAL UNITS
PERCENT OF AVERAGE LIFE
0 20 40 60 80 100 120 140 160 180 200 220 240 260
0 10 20 30 40 50 60 70 80 90 100

*Presented before National Association of Corrosion Engineers, Houston, Texas, April, 1944.

Fig. 1. Typical mortality curve for mortality frequency shown

Eagles...

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The airplane is the eagle of war, and the American eagle is swift, sure and deadly—with a hearty appetite for fuel.

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quency should be controlled by certain characteristics inherent in the units themselves as they are delivered from the manufacturer, then it is reasonable to assume that a group of renewal units secured from the same source would have a mortality frequency distribution that would conform to that of the original units. It is a matter of common experience that when a large number of units or joints of steel pipe are laid underground there will be a diversity in the rate at which the renewal of these units will be required during successive service years. If it could be shown that the mortality frequency distribution of the failures of the units in an installation of steel pipe was the result of a normal diversity in the quality of the individual units due to the process of pipe manufacture, then it would be reasonable to assume that the mortality frequency distribution of the renewals would follow those of the original group taken as a whole. It is hardly necessary, however, to call attention to the fact the rate of failures of steel pipe laid underground is a function of service age, corrosion intensity of the soil and the protective resistance to corrosion offered by coatings and is not materially affected by any diversity in the quality of the pipe itself. Since this is true, it is manifest that when a renewal of a section of pipe is made, the renewal will be subject to precisely the same external condition that brought about the failure of the original units and that if the renewal is made in kind the mortality characteristics of the renewal will conform to that of the units replaced rather than to that of the group taken as a whole[4].

This important fact, which is the result of severe corrosive conditions operating on localized sections of a line, will of necessity have a profound bearing upon the development of mortality frequency distribution curves based upon an interpretation of acturial data. It also suggests that any calculations for future performance which may be based upon the use of the formal methods suggested by Kurtz, Marston, and Agg will lead to erroneous conclusions.

It requires no special engineering qualifications to enable one to recognize the fact that the relative economic worth of any particular method of pipe protection must be established by a comparison of its overall cost with the overall cost of other methods of protection and with the overall cost of no protection at all. This general statement must, of course, be modified by: (1) a consideration of whatever value may be assigned to the contribution toward the maintenance of continuous service that will result from the use of some form of protection, and (2) by a consideration of the expected capital losses that may be suffered by a diminution in the service capacity of steel pipe as a result of accrued but unrealized depreciation which it is anticipated that the protection would mitigate.

These rather elementary conclusions lead immediately to the consideration of a factor that is not at all elementary. It may be assumed for the purpose of analysis that the capital expenditures and the future operating cost may be accurately determined for a scheme of protection which will assume the perpetuity of a given pipe line free from all expenditures for renewals or repairs. It may also be assumed that the present value of the initial and future costs of such an application can be readily determined for any specific life that may be assigned to the line. But just how are we to proceed in order to fix the present value of the future costs that such an application is assumed to have eliminated, a determination that must be made before the net economic worth of the scheme of protection can be established upon a rational basis?

Since it has been assumed that the cost of protection would eliminate all future costs for renewals and repairs, it is clear that there should be credited to this cost the entire sum of the present worth of the costs of all future renewals and repairs together with some consideration of the probability of service interruption and decline in line capacity. Inasmuch as the present worth of a series of future transactions, such as the renewal of joints of pipe in a line is a function of the interest rate and the number of units replaced at given time intervals, any accurate estimate of the sum of these present worths must be bottomed on experience data that will permit the development of reliable frequency distribution curves of annual renewals for both original units and replacements of original units. What has been said with respect to the true rate of future renewals applies with equal force to the true rate of repairs as distinguished from renewals. It should be here noted that normally there is a reciprocal relationship between the current renewal rate and the current rate of repairs on a pipe line that has had an extended service experience.

It is a fact demonstrated by experience that in situations where a large number of like property units are involved, the future mortality characteristics of these units can be most accurately anticipated by an analysis of the past mortality experience of a group of similar units that have been subjected to the same external conditions as those to which the units under investigation will also be subjected. For example in the matter of life insurance, basic premium rates are fixed from mortality survivor curves of large groups of individuals and not upon the physical examination of individuals. The actuary, who by the use of mortality data, is able to make mortality predictions with a high degree of accuracy, never sees the persons to whom the results of his calculations are applied. The physical examination of the individual merely determines his condition as related to the normal of an age group. In this connection it is hardly necessary to call attention to the fact that the actuaries conclusions relative to the percentage of a given age group that will survive any predetermined future age are much more accurate than would be the conclusions of a physician who may have made random physical inspections of a group of individuals of the same age.

While there is a close analogy between the examples above cited and what may be termed the actuarial and the inspection methods as applied to an estimation of the mortality characteristics of a group installation of steel pipe, the engineer who may be concerned with fixing the true economic worth of specific expenditures for pipe protection never finds himself in the enviable position of the life insurance actuary. All too often he is forced to accept evidence analogous to that which might be assembled by the examining physician.

Anyone who has had extended experience in the matter of collecting and interpreting data for use in estimating future annual renewal rates for steel pipe upon an acturial basis does not have to be reminded of the difficulties inherent in such a task. Even in situations where accurate renewal records have been maintained and where lines have been in service for more than 30 years, the basic mortality curves that may be developed from these records in practically all cases are mere stubs that represent relatively small percentages of the original group installations. In a recent investigation that involved the study of a large number of lines consisting of nearly 90,000,000 ft. of 3-in. equivalent diameter pipe in the oldest lines in the system having a service age of more than 30 years, the total renewals represented only 7.5 per cent of the original units installed. One main trunk consisting of approximately 200 miles of 18-in. pipe had renewals of less than 1 per cent after a service age of more than 13 years. Any engineer who would have the hardihood to extrapolate these meager data through a complete life cycle would certainly be endowed with a keen appreciation of his intuitive qualifications.

Fortunately there are other data that may be used to rationalize conclusions,

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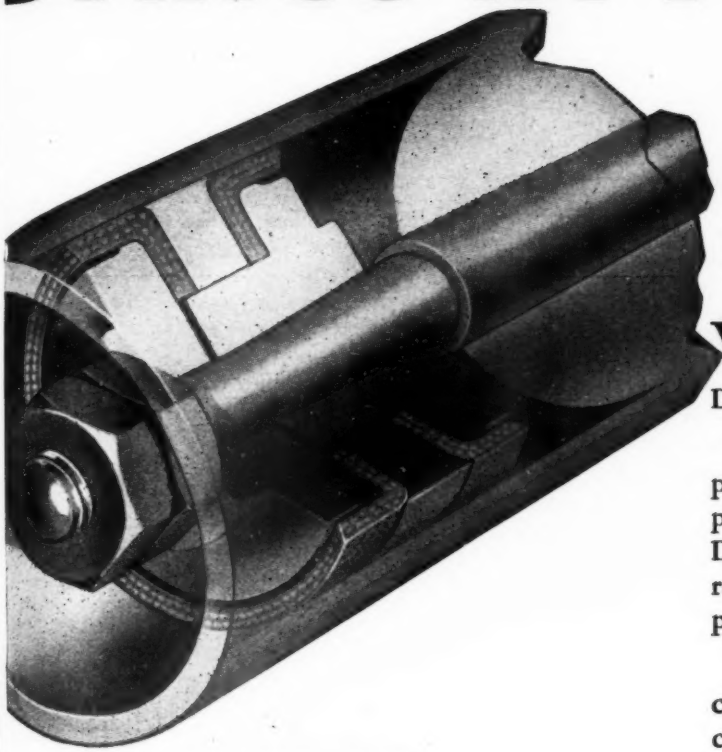

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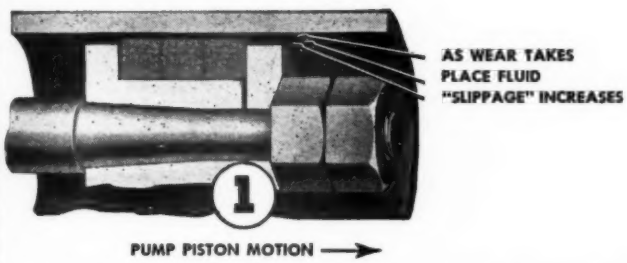

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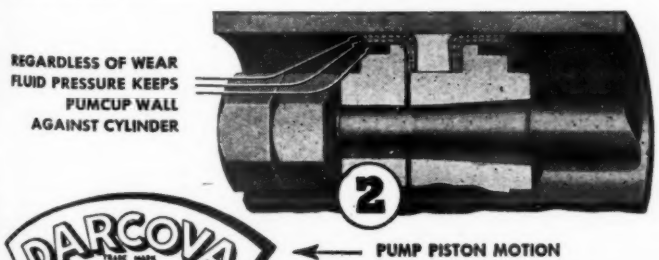

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which if drawn from renewal data alone would admittedly be highly speculative. If accurate records of line repairs are available (i.e., repairs that are brought about by the effects of corrosion) for a period of 10 or more years it will be found that trends may be developed that may be extrapolated with a reasonable assurance of the accuracy of the predictions. Considered solely from an apriori standpoint it would seem reasonable to assume that a repair curve for any given line (with the number of repairs in any given year as the ordinates and the corresponding service years as the abscissa) could be properly expressed as an exponential function. This conclusion follows the reasoning that the rate of increase in the number of repairs per annum due to corrosion would normally conform to the laws which govern the rate of growth of organic processes.

Under this assumption the rate of change of the function y (repairs) with respect to the rate of change of the independent variable x (service years) would be proportional to the function and would be expressed by the derivitive:

$$\frac{dy}{dx} = ay \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where a = the proportionality constant.

If equation (1) is divided by y and multiplied by dx we have:

$$\frac{dy}{y} = a\,dx \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Integrating (2) we have:

$$\log y = ax + C \text{ (log base e)} \quad . \quad (3)$$

From equation (3):

$$y = e^{ax+e} \text{ or } y = e^{e}\, e^{ax} \quad . \quad (4)$$

Since e^e is a constant, equation (4) may be expressed in final form

$$y = be^{ax} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where b and a are constants to be found for each set of observed data.

In the investigation previously referred to a study was made of repair data solely for the purpose of finding some rational method of extending the admittedly unsatisfactory renewal data. The results that were obtained were extremely interesting and have a direct bearing upon the subject under discussion.

When the historical repair data for each line were plotted on semi-log paper the distribution of the points indicated conformity to the general equation (5) and the first step in the investigation resolved itself into the derivation of the equation of the curve of best fit, in other words, the determination of the best values of the constants a and b in equation (5) for each set of observed data.

Before proceeding with the initial step, certain adjustments were made in the basic data in order to make them conform to the purpose of the investigation:

1. All repairs other than those that had a direct bearing on the condition of the pipe itself and thus upon the service life of its component parts were eliminated.

2. All repairs (as determined) for each calendar year on each line were expressed in terms of repairs per million feet of 3-in. equivalent diameter pipe exposed. This adjustment permitted a true comparison to be made between the repair trends on all lines observed.

Inasmuch as the lines were laid at different dates, the calendar years 1930-1941, inclusive, during which the repair data were accumulated, represented different service ages on the respective lines. This fact was taken into consideration in fixing the value of x for each line.

For the purpose of fixing the best value for a and b by the method of least squares, equation (5) was reduced to the straight line form.

$$y = Ax + B \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Where: $y = \log y$ (base 10),
$A = 0.4343a$,
$B = \log b$ (base 10), and
$B = 0.4343\,b$.

With the equation of the repair trend curve of best fit to the observed data determined in the manner above set out, it was then possible to calculate

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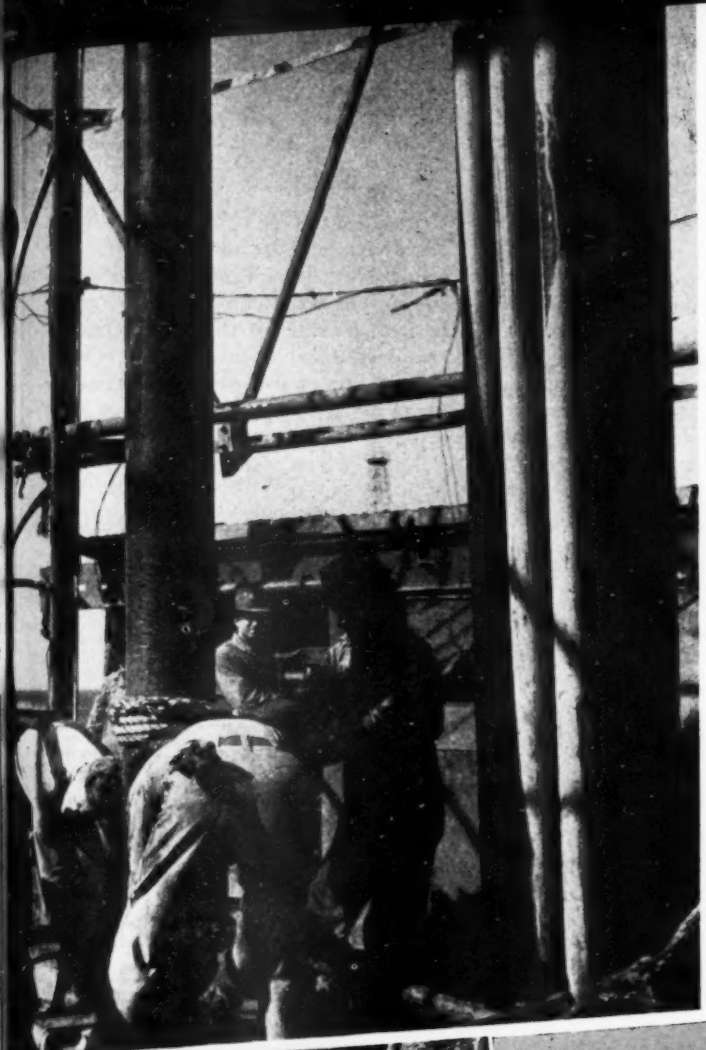

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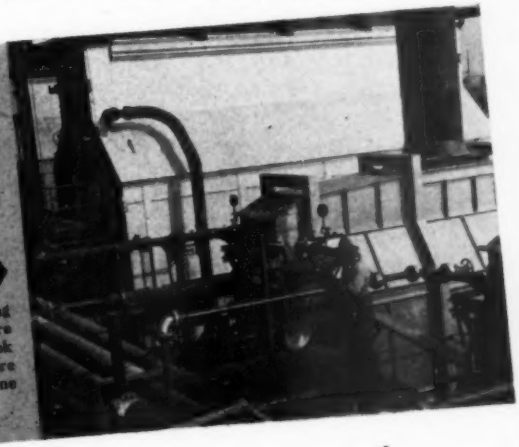

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the repairs per M^{-2} ft. of 3-in. E. D. P. for any value of x or for any assumed service age. In the case of each line the repairs were calculated for the respective service ages comprehended in the calendar year period 1930-1941, inclusive, and for an additional 10-year period.

With this information in hand it was a simple matter to determine the calculated repairs for each line (as distinguished from calculated repairs per M^{-2} ft. of 3-in. E. D. P.) for each year from 1930 to 1941. This calculation was made for the purpose of checking the results obtained from curves with the actual experience data.

It is not suggested that an extended extrapolation of the repair curve would reflect actual experience in situations where the indicated rate of increase in annual repairs would make it evident that the effect of renewals would cause a flexure in the slope of the curve. In fact the original purpose behind the preparation of these curves, as has been previously noted, was the thought that they might provide a basis for a rational estimate of the future rate of renewals on lines where little mortality data were available.

As previously stated, the replacement data are so meager and the renewal projections so vague that they must, of necessity, be supplemented by other data. The reciprocal relationship between the rate of repairs and the rate of renewals developed by the experience referred to on lines 1and 6 serve to emphasize, and to clarify, the interpretation of an extrapolation of these data. The decidedly opposite effect developoped by these two case histories indicate: (1) That a mortality study may have been made on the section of line suffering such high failures by treating the section of line as a single group installation; (2) that the installation of replacement units has a definite effect on the rate of repairs; (3) that conclusions be based upon the rate of failures per mile, whether repairs or replacements, on each section of line when the limits of attack can be defined.

The significant fact manifested by the effect of the replacement of property units on the rate of repairs, as distinguished from joints of steel pipe, is that the new units are, at the date of their installation, beginning a completely new life cycle. In cases where replacements and repairs are being made simultaneously the repair trend curve will be offset by some value depending upon the magnitude of the replacements.

The repair trend curves, as developed by this study, indicate an asymptotic relationship with the ordinates (total annual renewals) approaching a magnitude of infinity at some particular service age interval. However, it is obvious that before this particular service age is attained the service capacity will be so greatly reduced and the cost of repairs so high that it would no longer be economically feasible to continue operations on this basis.

When making a study of this type of problem the investigator must focus his attention upon some particular point of inflection of the repair trend curve. The total annual repairs developed by case history and the extrapolation of these data provide a basis upon which to estimate the future behavior of a potential liability.

The ultimate in any problem in vestance is to arrive at the cost of the continuous service. Property units having long service life characteristics that are subject to the ravages of corrosion demand that a rigid check on their condition be made at each service age interval. In these historical studies an interpretation of the repair trends have developed such conclusive evidence that bear out the fidelity of this analytical process, that our attention is directed toward the economic significance of this type of study. The summation of the future repairs when extrapolated from the curves of best fit can be translated into cost and these costs into the present worth of the estimated future liability.

Acknowledgment. I wish to express my most grateful appreciation for the many helpful suggestions and able assistance given by Ed C. Connor, who so generously contributed his time and patience in the preparation of this paper.

In addition, I wish to thank the management of the Lone Star Gas Company for their generosity and cooperative spirit in granting permission to use and present the material upon which this paper was written.

APPENDIX 1

Definition of Terms.

Service life. The service life of physical property is the time interval between the date of installation and the date of retirement. Service life is an actual figure and can be determined only after the unit has been retired.

Service age. The service age of physical property is the time interval between the date of installation and the date of inquiry. Service age is an actual figure which should be ascertainable at any time. The service age of a group installation of individual units must be measured from the date of the original installation of the group even though the group installation may consist entirely of renewals.

Life expectancy. The life expectancy of a unit of physical property is the estimated residual service years in the unit at the date of inquiry. Inasmuch as a determination of life expectancy is made prior to the time of retirement it is of necessity a matter of estimate.

Probable life. The probable life of a unit of physical property is the sum of its age and life expectancy in years at the date of inquiry.

Average life. The average life of a group installation of like property units is the average number of years of service rendered by the individual units. The average life of a group installation occurs at the service age when 50 per cent of the units in service have been retired.

Renewals. Renewals of the units of the group installation of like property units are their replacement in kind at the rate of retirement. During the age period covered by the service life of the oldest survivor of the original units the total renewals will consist in part of renewals of original units and in part of renewals of renewals. When the service life of the oldest survivor of the original units is exceeded, all renewals will be renewals of renewals.

Normal annual renewals. The normal annual renewals of a group installation of like property units are the annual renewals when they become approximately constant.

Mortality survivor curve. A mortality survivor curve shows graphically the number of the survivors of an original group installation of like property units expressed as percentages of the number of original units remaining in service at each age interval from the date of installation to the service life of the last survivor of the group.

Mortality frequency distribution curve. A mortality frequency curve, or mortality histogram, shows graphically the number of retirements of units of an original group installation of like property units, expressed as percentages of the number of original units, from the date of installation to the service life of the last survivor of the group.

Probable life curve. The probable life of a unit of physical property at a given age is the sum of its age and its life expectancy at that age.

APPENDIX 2

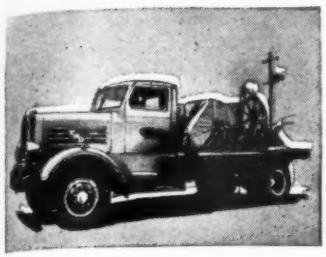
Development of basic mathematical formulas.[5] Certain basic formulas, while not essential to an understanding of the text, are suggested for use in comparing the mass of variable factors involved in problems of vestance, the equivalent cost of a permanent service.

Compound interest formula

Let:

P = principal sum,

r = rate of interest,



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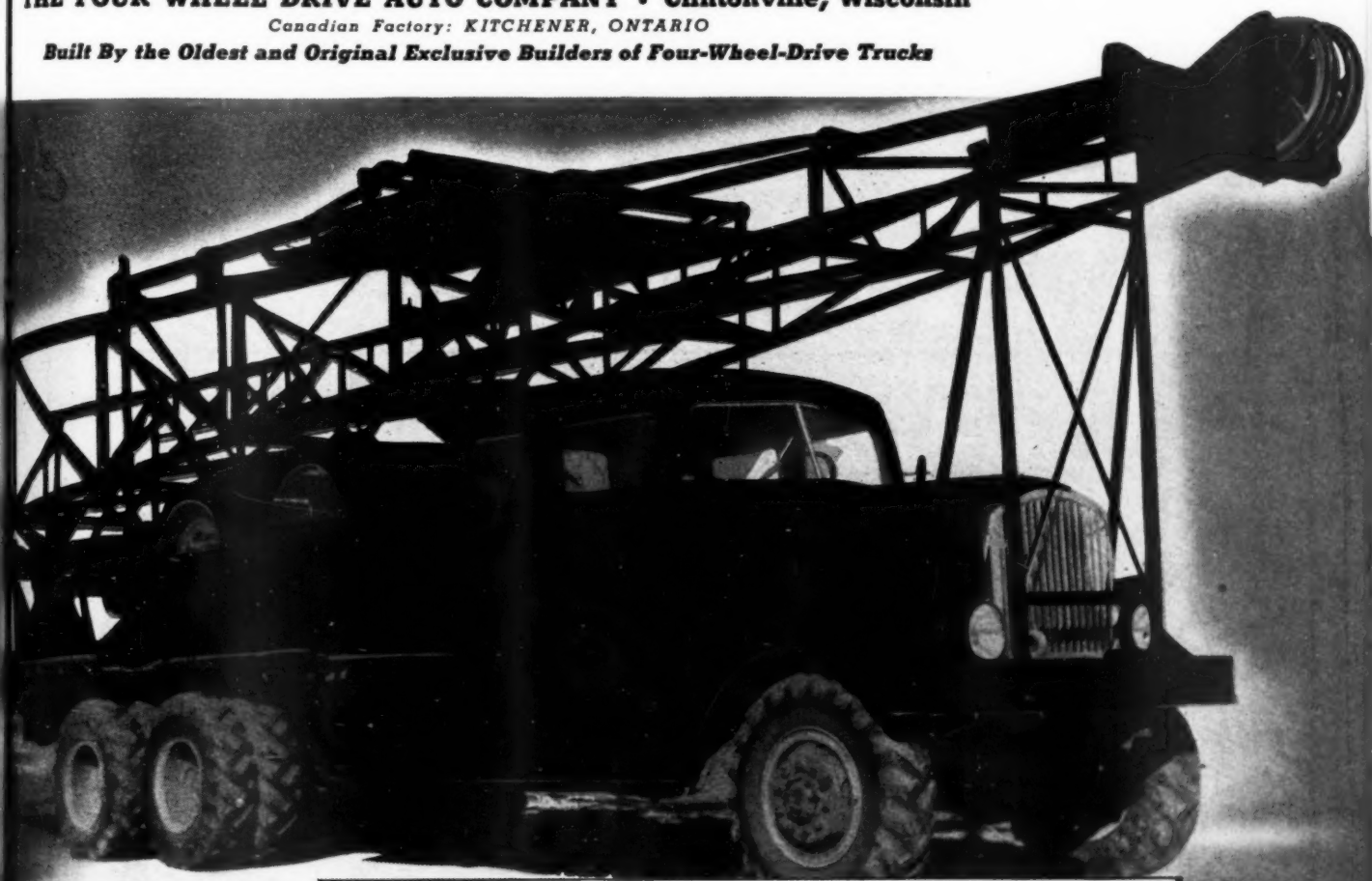

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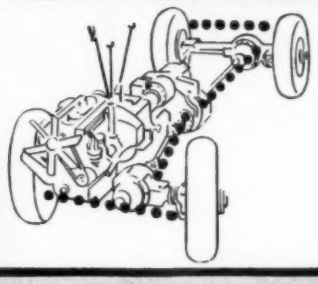

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n = number of years, and
A = amount at compound interest at any given time,

Then:

$$A = P(1+r)^n$$

Present worth formula

If it is assumed that a sum will earn compound interest at rate r for n years, the above formula can be rearranged to give the present worth of a sum payable in n years:

$$P = \frac{A}{(1+r)^n}$$

In this case P will equal the principal sum that has a value A payable in n years.

Annual depreciation rate

Let:

A = depreciation annuity in dollars,
r = interest rate,
V = first cost, or value in dollars,
n = life of the unit in years, and
D = depreciation rate in per cent.

From the above:

$$D = \frac{A}{V}$$

If at the end of year 1, A is set aside, the fund F at this period is equivalent to:

$$F_1 = A$$

At the end of the second year this will increase to $A(1+r)$.

The reserve will then be:

$F_2 = A(1+r) + A$, or
$A[(1+r)+1]$ dollars.

At the end of the third year this will increase to:

$$F_3 = A[(1+r)^2 + (1+r) + 1]$$

Therefore, at the end of n years the reserve will be:

$$F_n = A[(1+r)^{n-1} \; (1+r)^{n-2} \; \ldots \ldots \; (1+r)+1]$$

If the sum of the series $(1+r)^{n-1} + (1+r)^{n-2} \ldots$ etc., be allowed to equal S and both sides of the equation are multiplied by $(1+r)$ we have:

$$S(1+r) = (1+r)^n + (1+r)^{n-1} \ldots + (1+r)$$

Subtract

$$S = (1+r)^{n-1} \ldots + (1+r) + 1$$

$$Sr = (1+r)^{n-1} - 1$$

$$S = \frac{(1+r)^n - 1}{r}$$

Substituting the value of S in the equation evaluating F_n we have:

$$F_n = \frac{A}{r}[(1+r)^n - 1]$$

But according to the sinking fund assumption F_n (the reserve fund at n years) must be equivalent to the initial value V or first cost.

Then:

$$V = \frac{A}{r}[(1+r)^n - 1]$$

Therefore, D, the depreciation rate expressed as per cent of V will be:

$$D = \frac{r}{(1+r)^n - 1}$$

Present worth of depreciating property. According to the sinking fund theory of depreciation, the present worth or present value of any unit of property at any given time is equal to its original cost less accrued depreciation, or stated in other words, the present worth plus accrued depreciation should equal the first cost.

Letting W equal the present worth of the property units, the equation expressing this relationship is:

$$W = V - F_x$$

Whence:

$$W = V - \frac{V(1+r)^x - 1}{(1+r)^n - 1}$$

$$W = \frac{V(1+r)^n - (1+r)^x}{(1+r)^n - 1}$$

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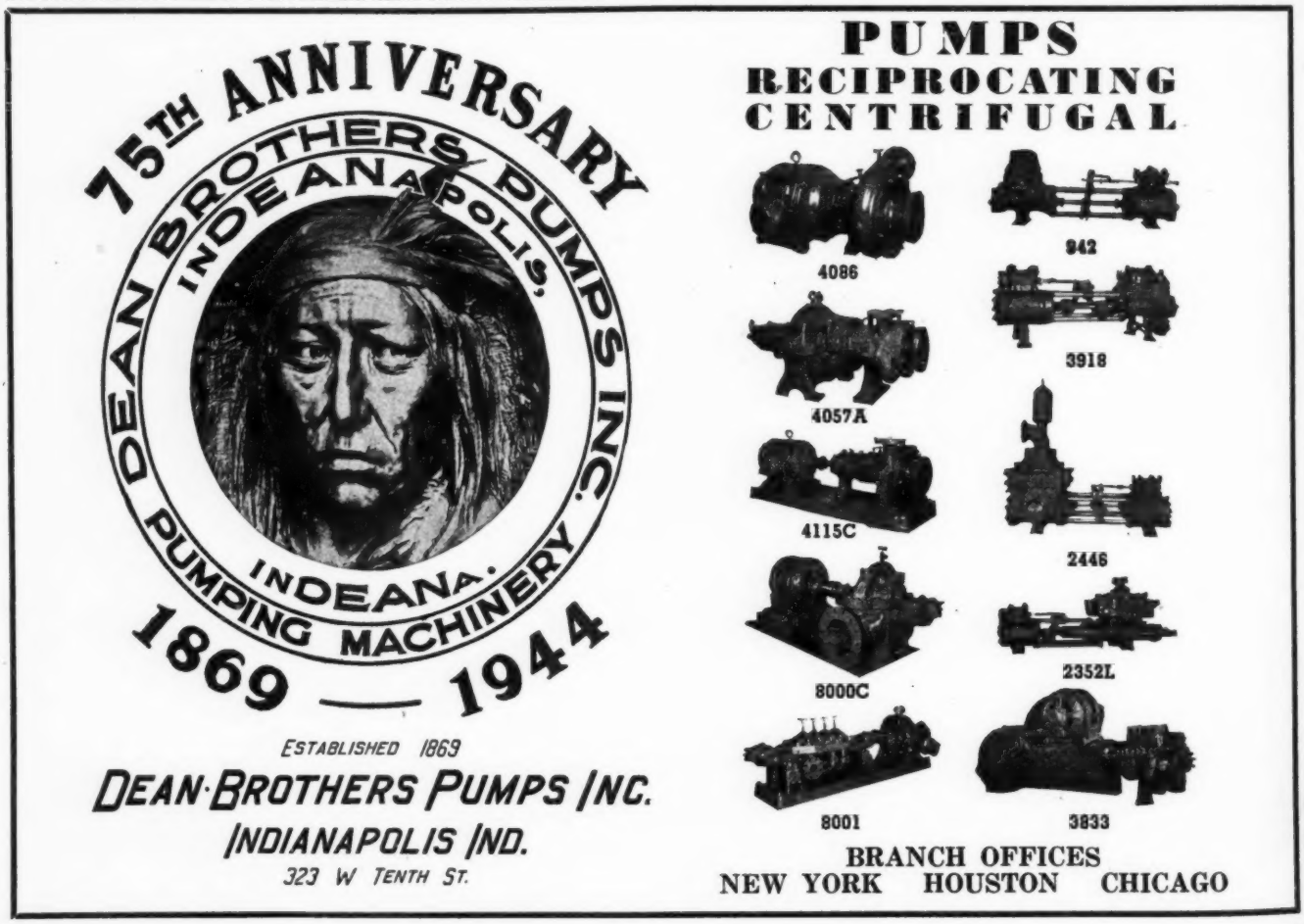
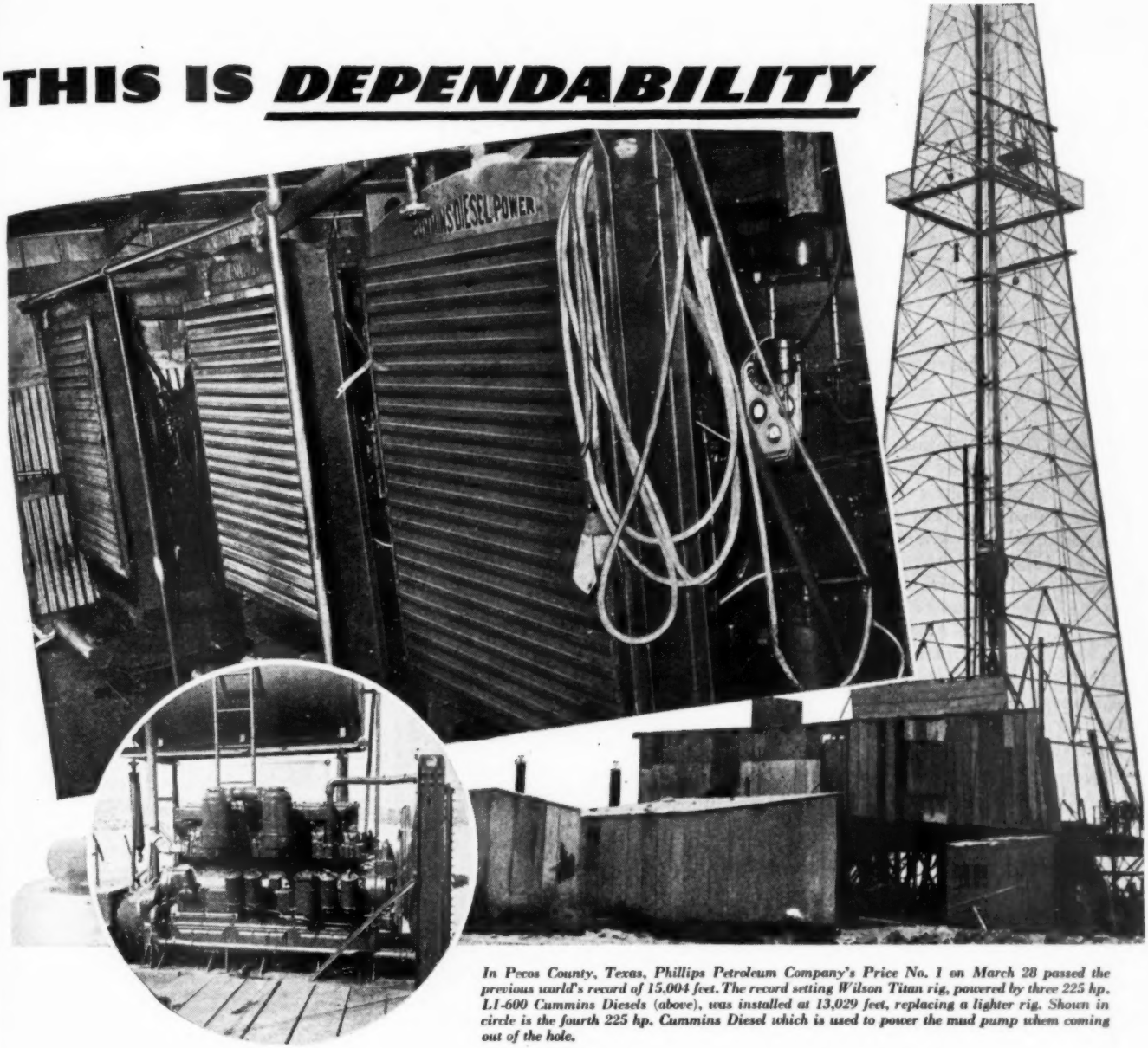
5. "Financial Engineering," by O. B. Goldman.

☆☆☆



THIS IS *DEPENDABILITY*



In Pecos County, Texas, Phillips Petroleum Company's Price No. 1 on March 28 passed the previous world's record of 15,004 feet. The record setting Wilson Titan rig, powered by three 225 hp. L1-600 Cummins Diesels (above), was installed at 13,029 feet, replacing a lighter rig. Shown in circle is the fourth 225 hp. Cummins Diesel which is used to power the mud pump when coming out of the hole.

When the four Cummins Diesels which drilled the Phillips Petroleum Company's Price No. 1 to a new world's record were moved in on that history-making job—they already had amassed a total of 125,448 hours of operation.

Two of these engines, each seven years old, had drilled 38,880 and 39,768 hours, respectively, when they tackled the Price well. The third—over six years in service—had logged 29,520 hours; and the fourth engine, almost three years old, 17,280 hours.

Here, again, is a demonstration of Cummins Diesel dependability . . . dependability with a capital "D" . . . proof with a capital "P" that Cummins Diesels, year after year, go right on delivering "new engine" performance on the toughest oil field jobs—drilling, pumping, or generating. CUMMINS ENGINE COMPANY, INC., Columbus, Ind.

CUMMINS DIESELS

SINCE 1918...PIONEER OF PROFITABLE POWER THROUGH HIGH SPEED DIESELS

Noise and Fire Hazards Eliminated in Drilling Elysian Park Well

PETROLEUM ENGINEER Exclusive Feature

☆ Well within Los Angeles city limits is being drilled directionally

by Wallace A. Sawdon
Pacific Coast and Foreign Editor

THE ever-increasing demand for oil in California to maintain the military and domestic supply under war conditions led the Seaboard Oil Company of Delaware to investigate the possibilities of the Elysian Park anticline situated within the city of Los Angeles. As the structure lay below park land and residential areas it was impossible to proceed with drilling in the conventional manner and considerable planning and study were necessary to provide a program that would satisfy all interests concerned.

Because of certain provisions in the Los Angeles city charter it was impossible to obtain the unqualified right to drill on the surface of Elysian Park; however, after many months of negotiations involving public bidding, the matter culminated in a contract to slant drill under the park. After nearly two years of concentrated planning and effort involving leasing, engineering studies, and agreements, Elysian Park Well No. 1 was spudded in.

The operation is soundproof and all known scientific methods are employed to prevent the escape of noxious odors, vibration, dust, or other disturbing elements. The steel derrick of conventional type was completely enclosed with a fire-resistant canvas quilting consisting of "Fiberglas" quilted between layers of canvas. This quilting was made up in panels to fit each girt section of the derrick, four panels being used for the four sides at each section as shown in the illustration.

The rig equipment is of the conventional electric-motor-powered type, all power for drilling being electricity. The drawworks is powered by two 125-hp. motors. The rotary table is driven either through chain from the drawworks or by a separate table drive powered by a 200-hp. motor. One pump is 7 in. by 16 in. driven by two 150-hp. motors and the other is a 7 in. by 18 in. driven by one 200-hp. motor. Remote magnetic control is provided for all motors. Alternating current is used throughout.

A string of 16-in. pipe was set at 80 ft. and a 11¾-in. surface string at 600 ft. Hole carried below the surface string was 10⅝-in.

The well location is on private fee property 425 ft. from the Elysian Park boundary. Completion being planned under park property, whipstocking was started at approximately 300 ft. Eastman Oil Well Survey Company is in charge of the controlled directional drilling. All equipment is owned by Seaboard Oil Company of Delaware but labor is supplied by the drilling contractors, Bell and Loffland, Inc.

☆ ☆ ☆

Elysian Park (Los Angeles) well of Seaboard Oil Company of Delaware

THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT NO. 85

A VALUABLE and regular feature of *The Petroleum Engineer,* the Continuous Tables, now in their seventh year of publication, were designed to save time and effort for the technician and the practical field or plant worker. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer.* Data are presented in the simplest form available with many types of information included that are best presented by curves or nomographs when three or more variables must be considered simultaneously.

The Continuous Tables have developed as a result of suggestions for new tables, direct contributions, and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue; 37-48, inclusive, in the June, 1941, issue; 48-60, inclusive, in the June, 1942, issue; 61-72, inclusive, in the June, 1943, issue, 73-79, inclusive, in the January, 1944, issue, and 80-82, inclusive, in the April, 1944, issue.

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Hazard Wire Rope Division of American Chain and Cable Co., Inc.	(sheet 2)	144	July	P 514.535.
Hyatt Bearings Division, General Motors Sales Corporation	(sheet 3)	156	July	P 514.535.
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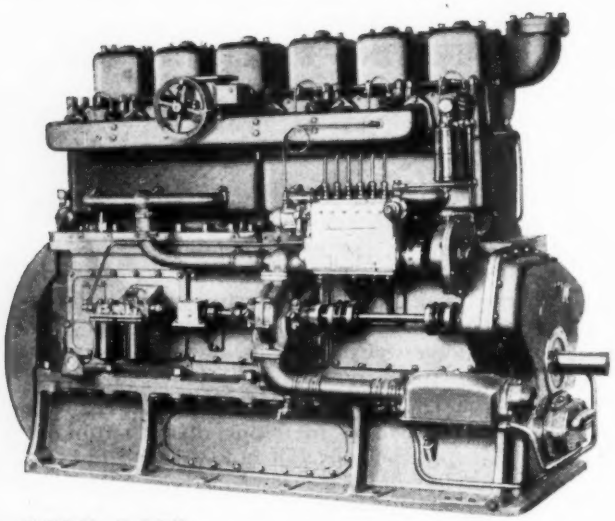
Nash Engineering Co.	(sheet 1)	154	July	P 533.401.1
Torrington Company, Bantam Bearings Division		146	July	P 425.218.000.

WAUKESHA

HESSELMAN *Oil* ENGINES



MODEL 6-LRH

In wartime every Waukesha Engine is a war-work engine. All Waukesha production is for the use of the armed forces. Until the war is won, Waukesha postwar engine designs are not being shown.

But peacetime models are on the way. New advantages and greater user conveniences will make the new peacetime Waukesha-Hesselman *the world's most wanted diesel-oil engine.*

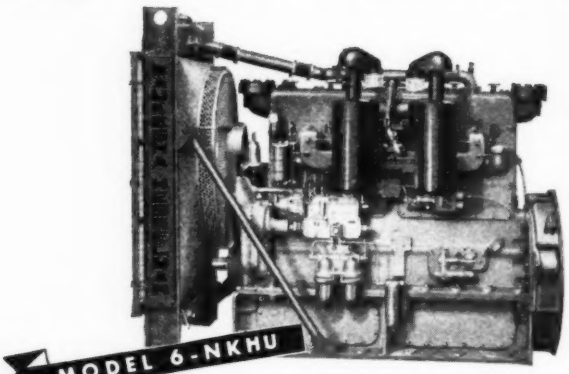
After the war the fuel problem for engine-driven equipment will be serious *unless it is Hesselman powered.* Because it burns those widely sold Nos. 1, 2 or 3 domestic furnace oils as well as high-speed diesel fuels . . . either high or low cetane. . . Hesselman will be the operator's first choice for country-wide use. And a Hesselman may be converted from fuel injection to carbureted gas or gasoline without changing a single major part. *No compression ignition Diesel can be converted from fuel oil to gas or gasoline so quickly, or easily.* Even gasoline injection is possible with the Hesselman.

And Hesselman's *electric and positively timed ignition* and lower pressures give easier starting, less shock load, longer life, lower upkeep than with any other diesel-oil engine.

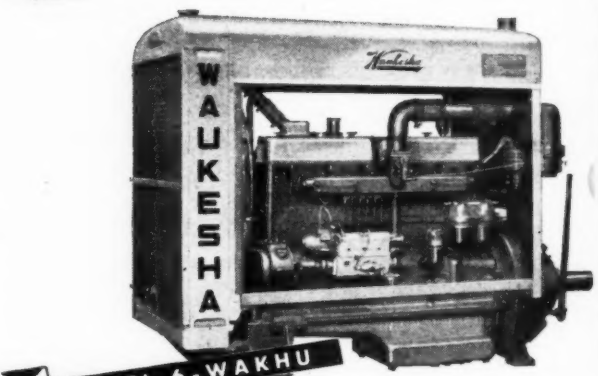
For your future engine needs, consult Waukesha now. Get Bulletin 1079

Engine Model	No. of Cyls.	Bore and Stroke, In.	Displ. Cu. In.	Speed RPM
*130-HS	4	3¾ x 5	221	1000-1800
*130-HL	4	4 x 5	251	1000-1800
*VRZH	4	4⅝ x 5¼	353	1000-1600
*140-HS	6	4¼ x 5½	468	1000-2250
*140-HK	6	4½ x 5½	525	1000-2250
*145-HK	6	5¼ x 6	779	1000-2000
6-WAKH	6	6¼ x 6½	1197	800-1600
6-NKH	6	7 x 8½	1962	600-1050
6-LRH	6	8½ x 8½	2894	600-1050

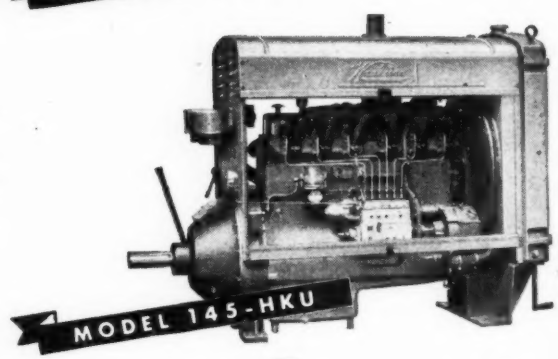
*These Hesselman Engines are true *multi-fuel engines*, and can be converted to burn natural gas or gasoline, with no internal changes. The others can also be converted to carburetor engines with a minimum of effort.



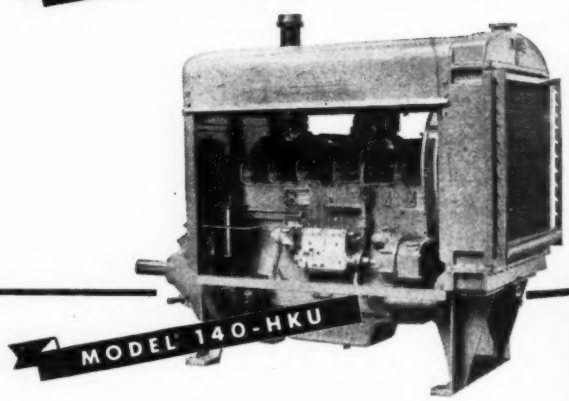
MODEL 6-NKHU



MODEL 6-WAKHU



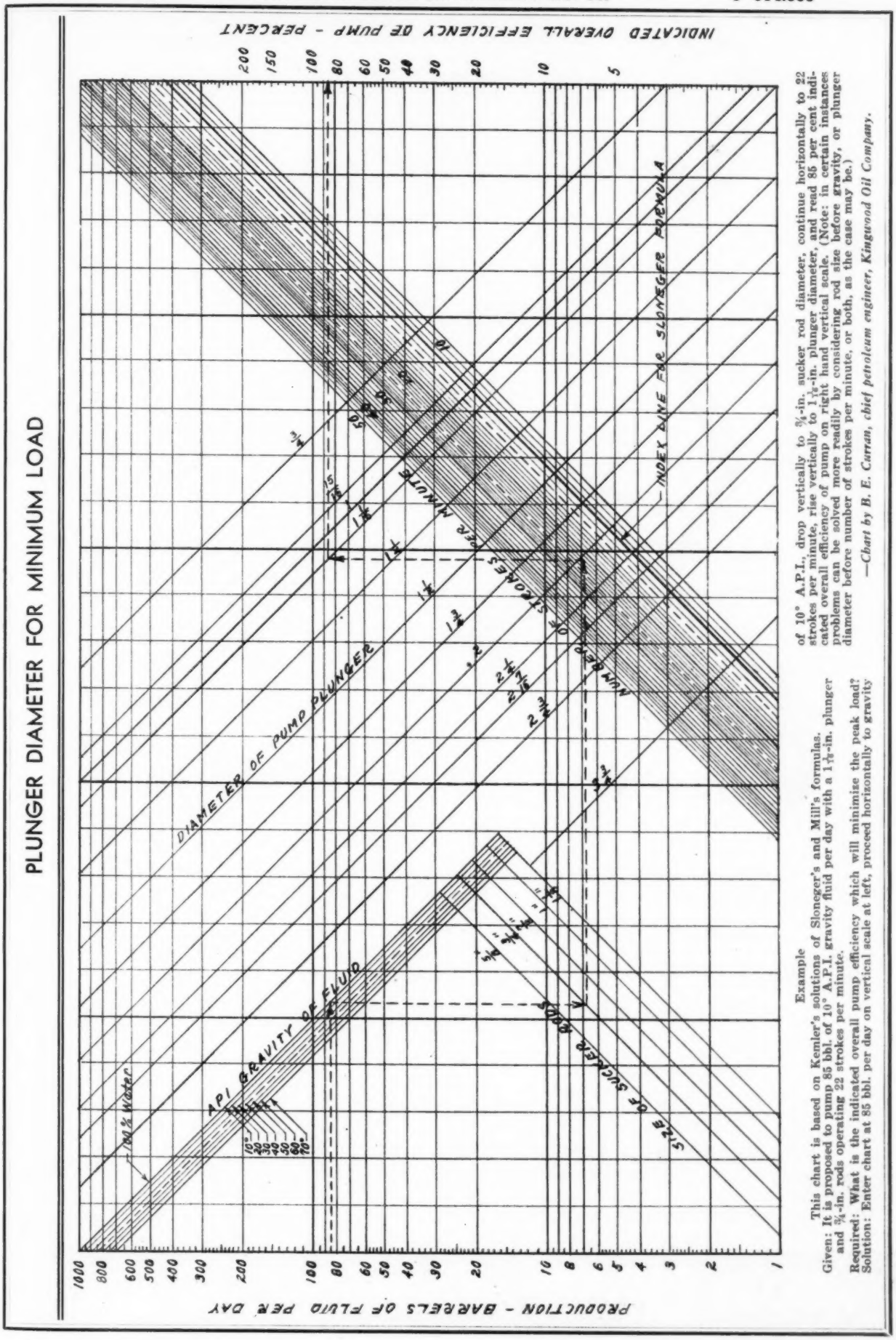
MODEL 145-HKU



MODEL 140-HKU

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.

NEW YORK • TULSA • LOS ANGELES


PLUNGER DIAMETER FOR MINIMUM LOAD
INDICATED OVERALL EFFICIENCY OF PUMP - PERCENT
PRODUCTION - BARRELS OF FLUID PER DAY
INDEX LINE FOR SLONEGER FORMULA
DIAMETER OF PUMP PLUNGER
STROKES PER MINUTE
API GRAVITY OF FLUID
10% Water
SIZE OF SUCKER RODS

Example

This chart is based on Kemler's solutions of Sloneger's and Mill's formulas.

Given: It is proposed to pump 85 bbl. of 10° A.P.I. gravity fluid per day with a 1¼-in. plunger and ¾-in. rods operating 22 strokes per minute.

Required: What is the indicated overall pump efficiency which will minimize the peak load?

Solution: Enter chart at 85 bbl. per day on vertical scale at left, proceed horizontally to gravity of 10° A.P.I., drop vertically to ¾-in. sucker rod diameter, continue horizontally to 22 strokes per minute, rise vertically to 1¼-in. plunger diameter, and read 85 per cent indicated overall efficiency of pump on right hand vertical scale. (Note: in certain instances problems can be solved more readily by considering rod size before gravity, or plunger diameter before number of strokes per minute, or both, as the case may be.)

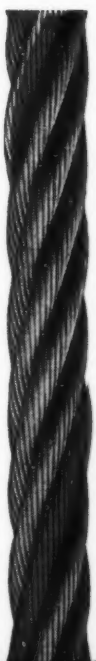
—*Chart by B. E. Curran, chief petroleum engineer, Kingwood Oil Company.*

. . . LAY-SET *Preformed* IS AT EASE

Putting non-preformed wire rope on your machines is like putting shackles on a policeman. You shouldn't expect a wire rope that is twisted tightly, and under constant tension, to operate well or long.

In Hazard **LAY-SET** Preformed every wire and strand is pre-shaped to the exact curve it assumes in the finished rope. That's why **LAY-SET** is at ease, relaxed, free to work and work willingly. Being free of torsional stress, Hazard **LAY-SET** Preformed lasts longer, gives you greater dollar value. Be sure your next rope is Hazard **LAY-SET** Preformed.

Ever since Pearl Harbor, and even before, Hazard **LAY-SET** Preformed has been saving time and money for the Government, the Armed Forces, and the taxpayer.



HAZARD WIRE ROPE DIVISION • Wilkes-Barre, Pa., Chicago, Pittsburgh, Fort Worth, Houston, Wichita, San Francisco, Denver, Los Angeles

Distributors in all important oil field centers

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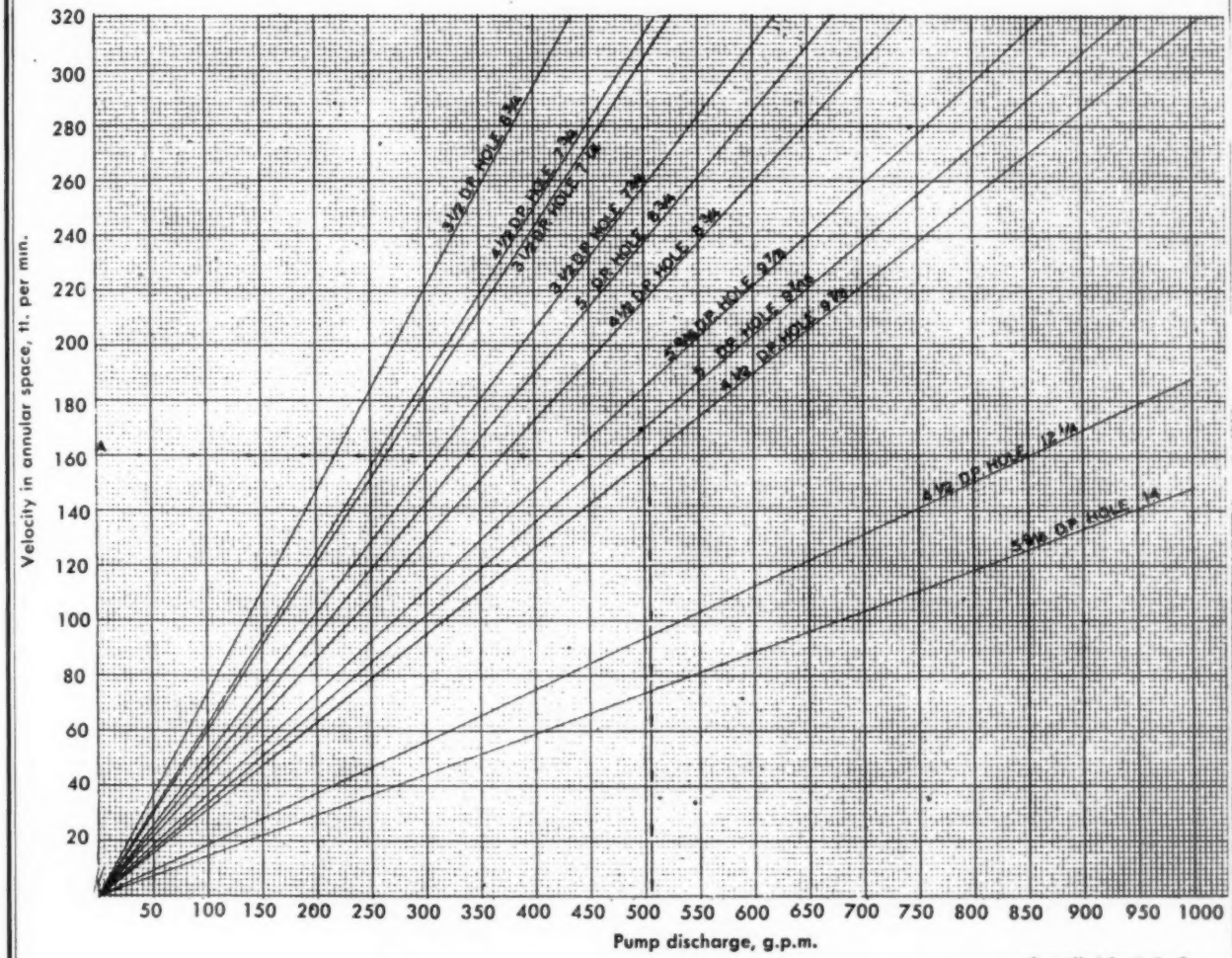
GREEN SIGNIFIES SAFETY

HAZARD LAY-SET *Preformed* ROTARY LINES

DRILLING MUD COMPOSITE CURVES—VELOCITY, VOLUME, AND PRESSURE



—Compiled by J. L. S.

Composite curve—annular return velocity versus mud circulation

Example for use of above chart:

The drilling operator wishes to drill an 8000-ft. well using 4½-in. IF drill pipe and bits with three 7/8-in. nozzles for 9⅞-in. holes. Drilling conditions require a return velocity of 160 ft. per minute.

Solution:

A on the above chart is at 160 ft. per minute. Move horizontally across the chart to the curve for 4½-in. drill pipe, 9⅞-in. hole, and then vertically to the pump discharge, g.p.m., scale at 505 g.p.m. This is the quantity of fluid required to be delivered by the pump. It will be observed that with any three of the four factors known, drill pipe size, hole size annular return velocity, or gallons per minute, the curves permit determination of the fourth factor from the curve.

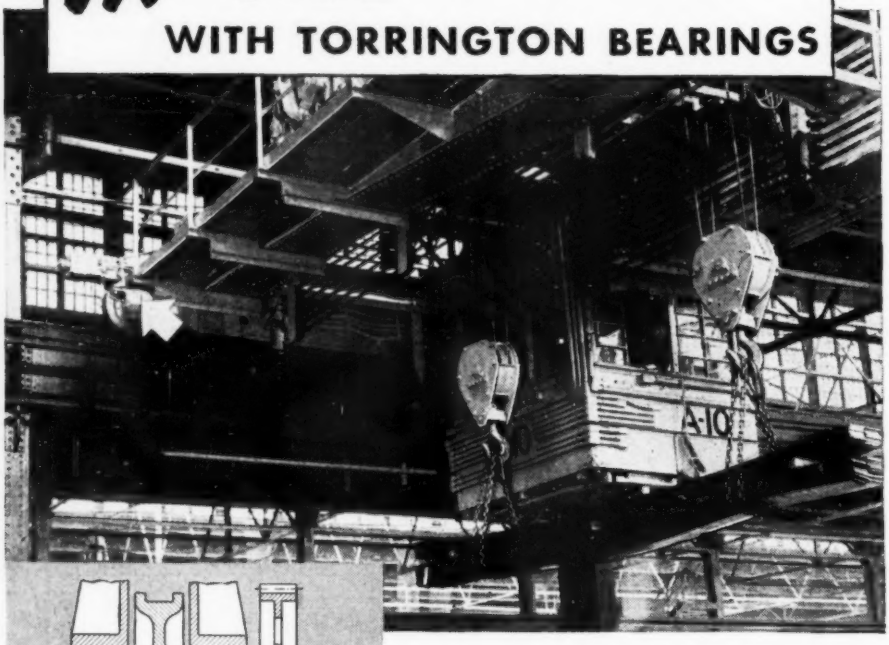
Sheet 2:

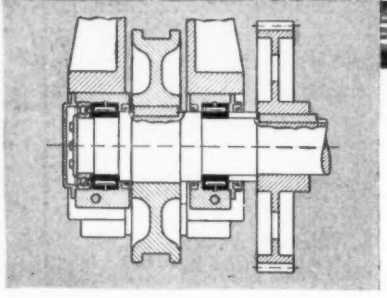
The chart shown on Sheet 2 is for determining the pressure, gallons per minute, or depth of hole when any two of the three factors are known. Starting on the horizontal scale at A, 505 g.p.m., move vertically to the 8000-ft. depth curve and then horizontally to the discharge pressure scale and read 1160 lb. per sq. in., the pressure required on 505 g.p.m. to obtain 160 ft. per minute return velocity with 4½-in. drill pipe, 9⅞-in. bit with three 7/8-in. nozzles.

—Chart by courtesy Gardner-Denver Company.

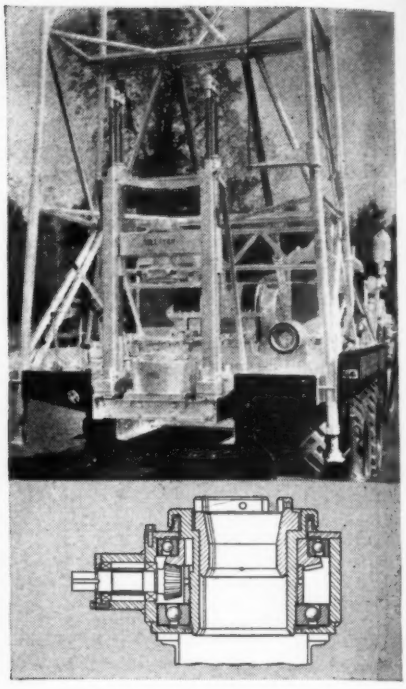
IN THE NEWS

WITH TORRINGTON BEARINGS

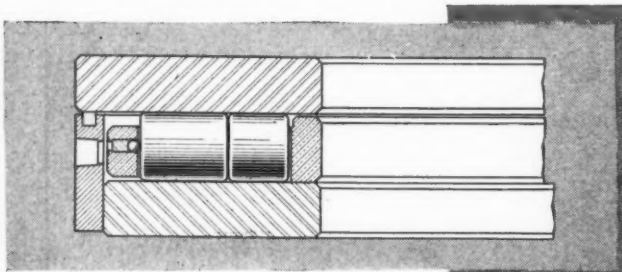


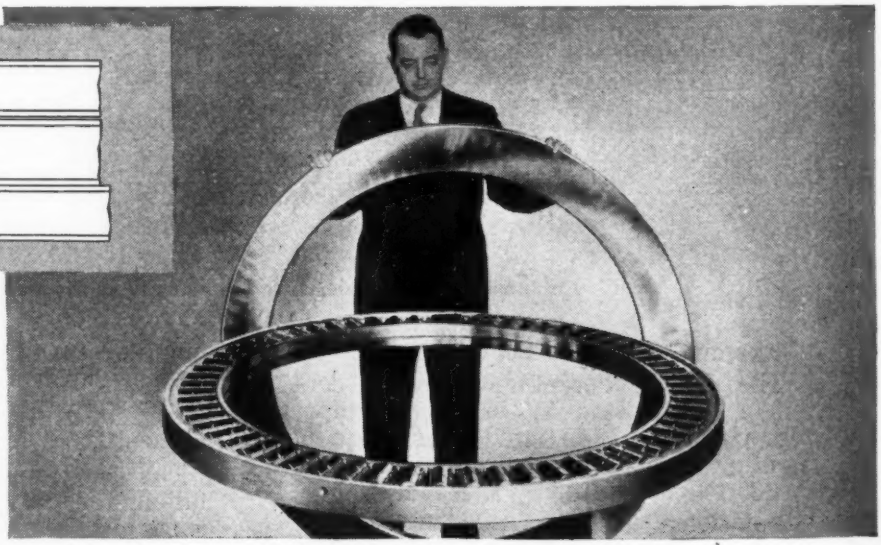


THE TREMENDOUS LOADS of this 15-ton overhead traveling crane in the Gary Steel Works of Carnegie-Illinois Steel Corporation are entrusted to bearings supplied by Torrington's Bantam Bearings Division. Two sets of Type NCS Heavy-Duty Needle Bearings, selected because of their high load capacity and compact design, are used in each axle housing, Torrington Ball Radial Bearings taking up the thrust load.



PLOTTING THE UNDERGROUND topography to determine where oil producing wells should be drilled is the important operation performed by this complete portable drilling unit manufactured by the Sullivan Machinery Company. To withstand the shocks, due to sudden changes in resistance as the drill bores through successive strata of soil, sand, water and solid rock, Torrington Ball Radial Bearings were selected for use in the rotary table assembly, as shown in the accompanying cross-section.





THIS HUGE ROLLER THRUST BEARING, measuring 53.125" O.D., is an example of Torrington engineering facilities for designing large bearings to carry extremely heavy loads. Its assembly includes 68 rollers 2" long and 1.5" in diameter; 68 rollers 1.375" long and 1.5" in diameter. The bearing is employed in the revolving mechanism of a large charging crane which serves the plate mill pre-heating furnace in one of the nation's major steel plants. Cross-section shows how felt packing was used to prevent entrance of scale and foreign matter during operation of the crane.

WHEN YOU SPECIFY Torrington Bearings, you have available specialized engineering service based on many years of experience with all types of bearing applications. Whether you need counsel on standard or custom-built bearings, TURN TO TORRINGTON.

ARMY E NAVY

TORRINGTON BEARINGS

STRAIGHT ROLLER • TAPERED ROLLER • NEEDLE • BALL

THE TORRINGTON COMPANY • BANTAM BEARINGS DIVISION

SOUTH BEND 21, INDIANA

HEAT TRANSMISSION THROUGH FURNACE WALLS

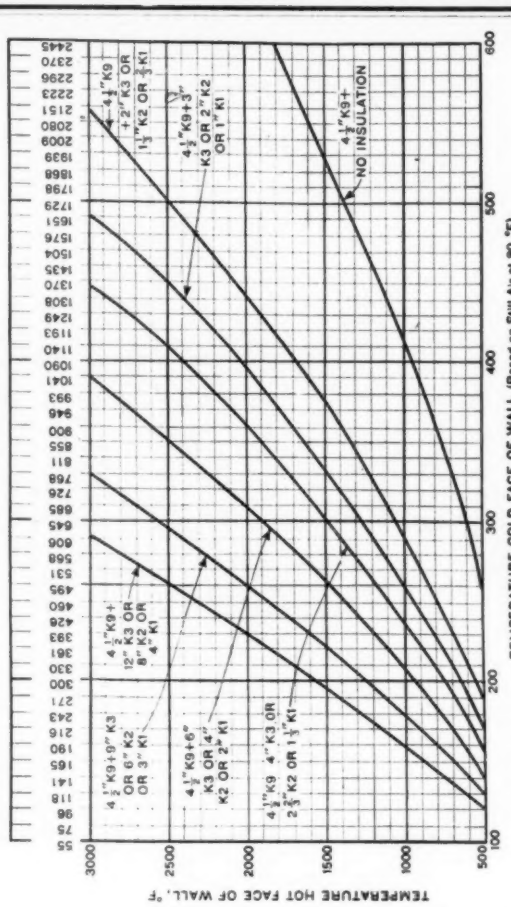

HEAT LOSS IN Btu./Hr./Sq. Ft.
TEMPERATURE HOT FACE OF WALL, °F
TEMPERATURE COLD FACE OF WALL (Based on Still Air at 80 °F)
4½" K9+9" K3 OR 6" K2 OR 3" K1
4½" K9+ 4½" K3 OR 12" K2 OR 8" K1
4½" K9+6" K3 OR 4½" K2 OR 2" K1
4½" K9 4" K3 OR 2⅔" K2 OR 1⅓" K1
4½" K9+ NO INSULATION

Fig. 9. Wall of two components, thickness and K-values as shown

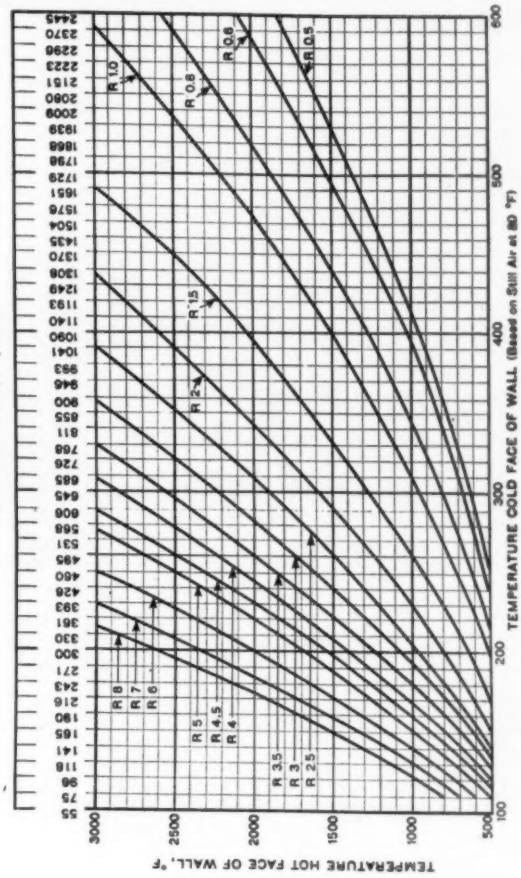


Fig. 10. Wall of one or more components with R from 0.5 to 8.0

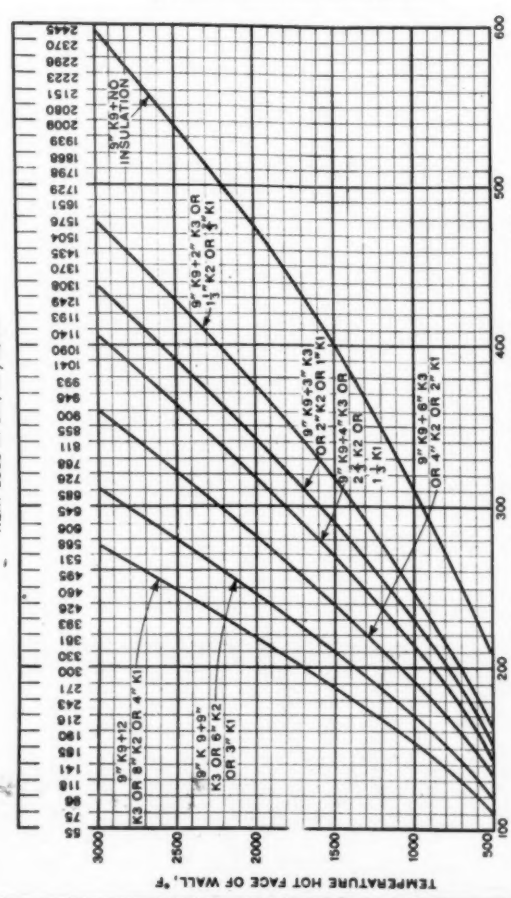

HEAT LOSS IN Btu./Hr./Sq. Ft.
TEMPERATURE HOT FACE OF WALL, °F
TEMPERATURE COLD FACE OF WALL (Based on Still Air at 80 °F)
9" K9+12 K3 OR 8" K2 OR 4" K1
9" K 9+9" K3 OR 6" K2 OR 3" K1
9" K9+2" K3 OR 1⅓" K2 OR ⅔" K1
9" K9+3" K3 OR 2" K2 OR 1" K1
9" K9+4" K3 OR 2⅔ K2 OR 1⅓ K1
9" K9+6" K3 OR 4" K2 OR 2" K1
9" K9+NO INSULATION

Fig. 8. Wall of two components, thickness and K-values as shown

DIRECTIONS FOR USE OF CHART

Fig. 8 and Fig. 9 are two component wall charts with the thickness and K-value as shown. Select chart corresponding to K-factor and thickness of refractory on hot-face of wall. Each curve applies to this refractory wall with the indicated insulating on the cold side. Read directly cold-face temperature (below) and heat loss (above). In most cases a choice of insulating materials is indicated. For any one curve K/L for the several insulating materials is the same. Joint temperature should be determined in order to avoid use of an insulating material above its temperature range.

To obtain temperature on hot face of insulation in Fig. 8, subtract B.t.u. loss from temperature of hot face of wall. The chart may be used where 7½ in. of K 7½ replaces 9 in. of K 9. In Fig. 9 to obtain temperature on hot face of insulation, subtract ½ B.t.u. loss from temperature of hot face of wall.

Fig. 10 calculations are as follows:

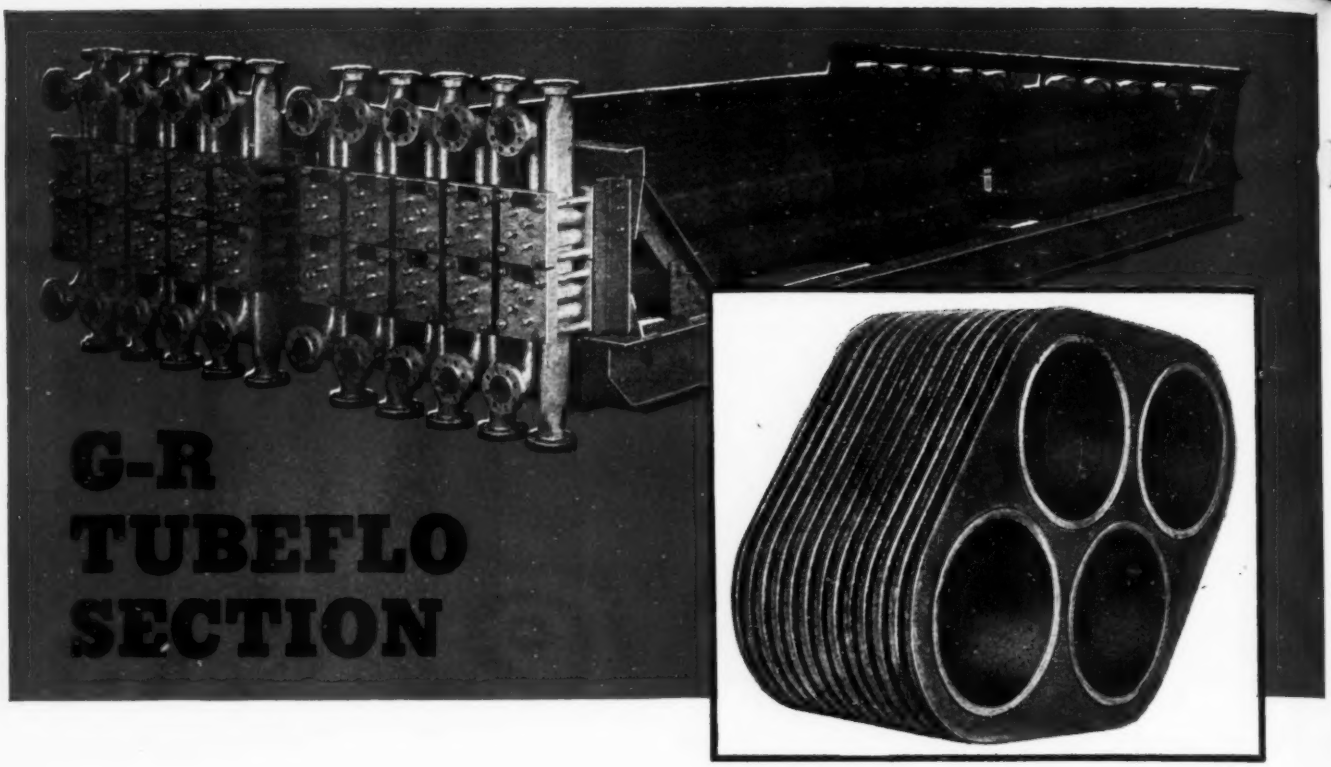
Temp. first joint from hot face = hot face temp. — B.t.u. loss × L_1/K_1.

Tempt. at second joint from hot face = first joint temp. — B.t.u. loss × L_2/K_2.

For a one component wall R = L/K, where: L = thickness of wall, in., K = conductivity (B.t.u. per sq. ft. per °F. diff. in temp. per in. thick).

For a wall of n components $R = L_1/K_1 + L_2/K_2 + \ldots L_n/K_n$; where L_1, L_2, etc. = thickness of each component and K_1, K_2, etc. = conductivity of each component.

This series of tables by courtesy of copyright owner, The Atlas Lumnite Cement Company.



. . . maintains rated heat transfer with dirty or tarry fluids

Here is a heat exchanger that resists fouling or clogging because of the large and uniform cross-section of all passages and high velocity of flow. Contamination of fluids is positively prevented, because leakage cannot possibly occur between the two sides of the unit. The design is ideal for high pressures and temperatures, because all fluid passages are reinforced throughout their entire length. These and additional important advantages of the G-R Tubeflo Section have been proven in over 3,500 installed units and by more than 15 years of service records.

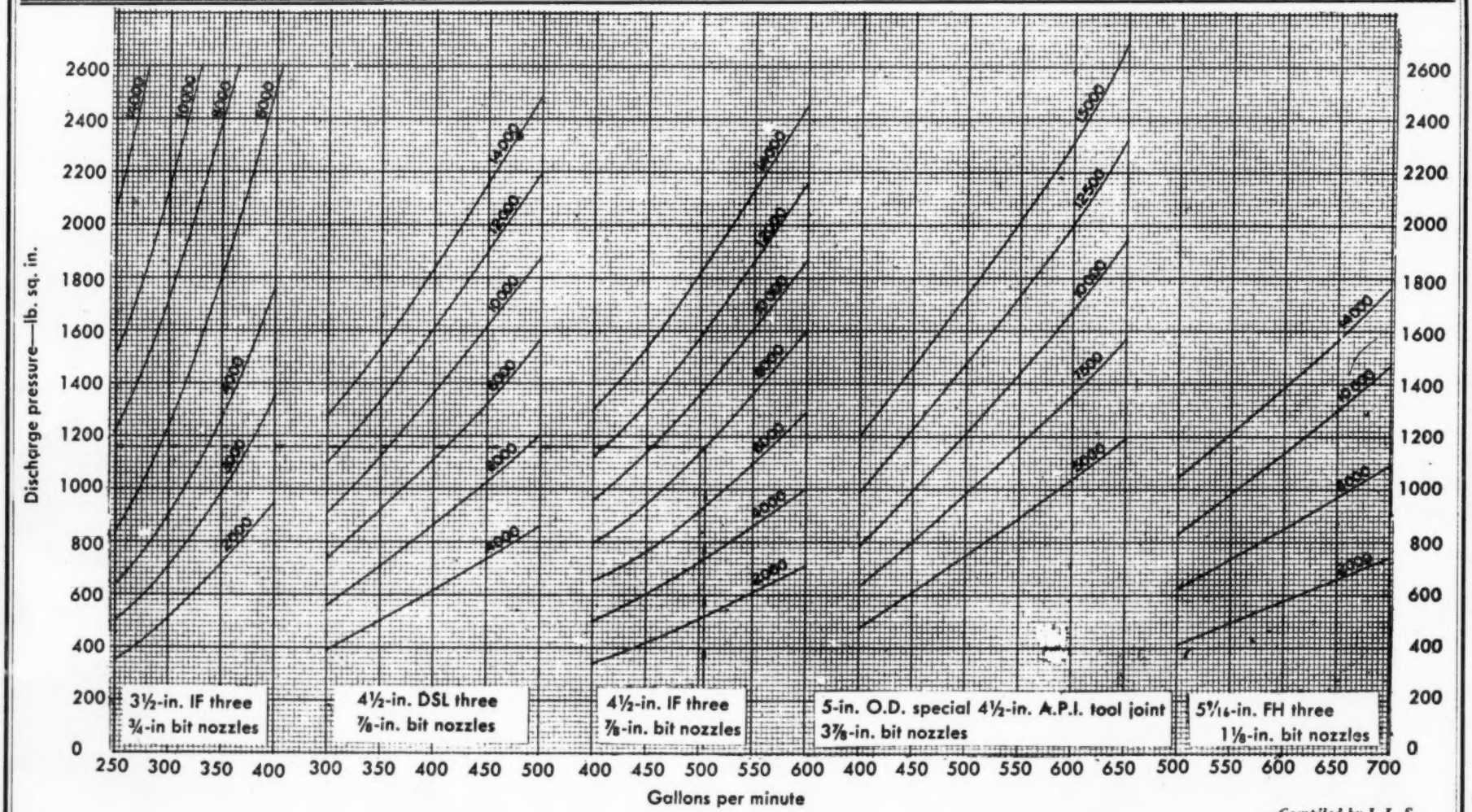
Write for Bulletin describing G-R Tubeflo Section features in detail

The Griscom-Russell Co.
285 Madison Avenue
New York 17, N.Y.

GRISCOM-RUSSELL

Pioneers in Heat Transfer Apparatus

DRILLING MUD COMPOSITE CURVES—VELOCITY, VOLUME, AND PRESSURE


Discharge pressure—lb. sq. in.
Gallons per minute
3½-in. IF three ¾-in bit nozzles
4½-in. DSL three ⅞-in. bit nozzles
4½-in. IF three ⅞-in. bit nozzles
5-in. O.D. special 4½-in. A.P.I. tool joint 3⅞-in. bit nozzles
5⁷⁄₁₆-in. FH three 1⅛-in. bit nozzles

—Compiled by J. L. S.

Composite curve—10 lb. per gal. mud, lb. per sq. in. drop in circulating system

The above curves are based on average conditions and are to be used for comparison with the different sizes of drill pipe. Variations will occur in some cases where specific gravity, mud viscosity, and water courses in the bits differ from those used for these data. Data for the curves included manifold losses, bit losses, friction losses in the pipe, and annular return losses.

When the volume has been determined from the chart on Sheet 1, 505 g.p.m., it may be used as a starting point on this chart to determine the pump pressure required for the velocity of 160 ft. per minute. Starting on the horizontal scale at A, 505 g.p.m., move vertically to the 8000-ft. depth curve and then horizontally to the discharge pressure scale and read 1160 lb. per sq. in., the pressure required on 505 g.p.m. to obtain 160 ft. per minute return velocity with 4½-in. drill pipe, 9⅞-in bit with three ⅞-in. nozzles.

The chart can be used for determining the pressure, gallons per minute, or depth of hole when any two of the three factors are known.

—Chart by courtesy Gardner-Denver Company.

WHAT

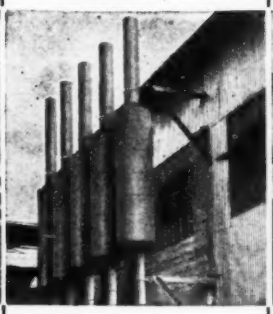
EXHAUST AND INTAKE SILENCERS

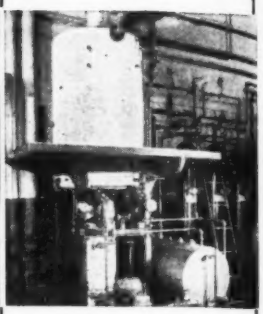
SPARK ARRESTOR SILENCERS

STEAM BLOW-OFF SILENCERS

HEAT RECOVERY SILENCERS

WHERE





WHEN

● These Maxim Silencers are designed to silence the exhaust or intake of internal combustion engines, steam engine exhausts, air compressor intakes, vacuum pump discharge and the intake or discharge of blowers of the positive pressure type. Wide choice of models to fit varying space and silencing requirements.

● Maxim Spark Arrestor Silencers effectively silence exhaust noise and in addition provide for 100% trapping of all sparks and embers which might come from the exhaust. Of obvious value in marine use, these Spark Arrestors are also applicable to industrial use where a fire hazard exists.

● These silencers were developed for use on installations involving the discharge of high velocity steam, air or gas to atmosphere. Used for steam blow-off, safety valve discharges, etc. Silencers shown above installed on high velocity steam exhaust have a total capacity of 135,000 lbs. per hour.

● Maxim Heat Recovery Silencers combine efficient silencing of engine exhaust with spark arresting (where necessary) and with the recovery of waste exhaust heat to produce steam or hot water. Highly efficient heat transfer . . . automatic controls . . . may be run wet or dry.

HOW

BULLETINS: D125, D127, D101, D37, D16.

BULLETINS: D105 and D33.

BULLETIN: D111.

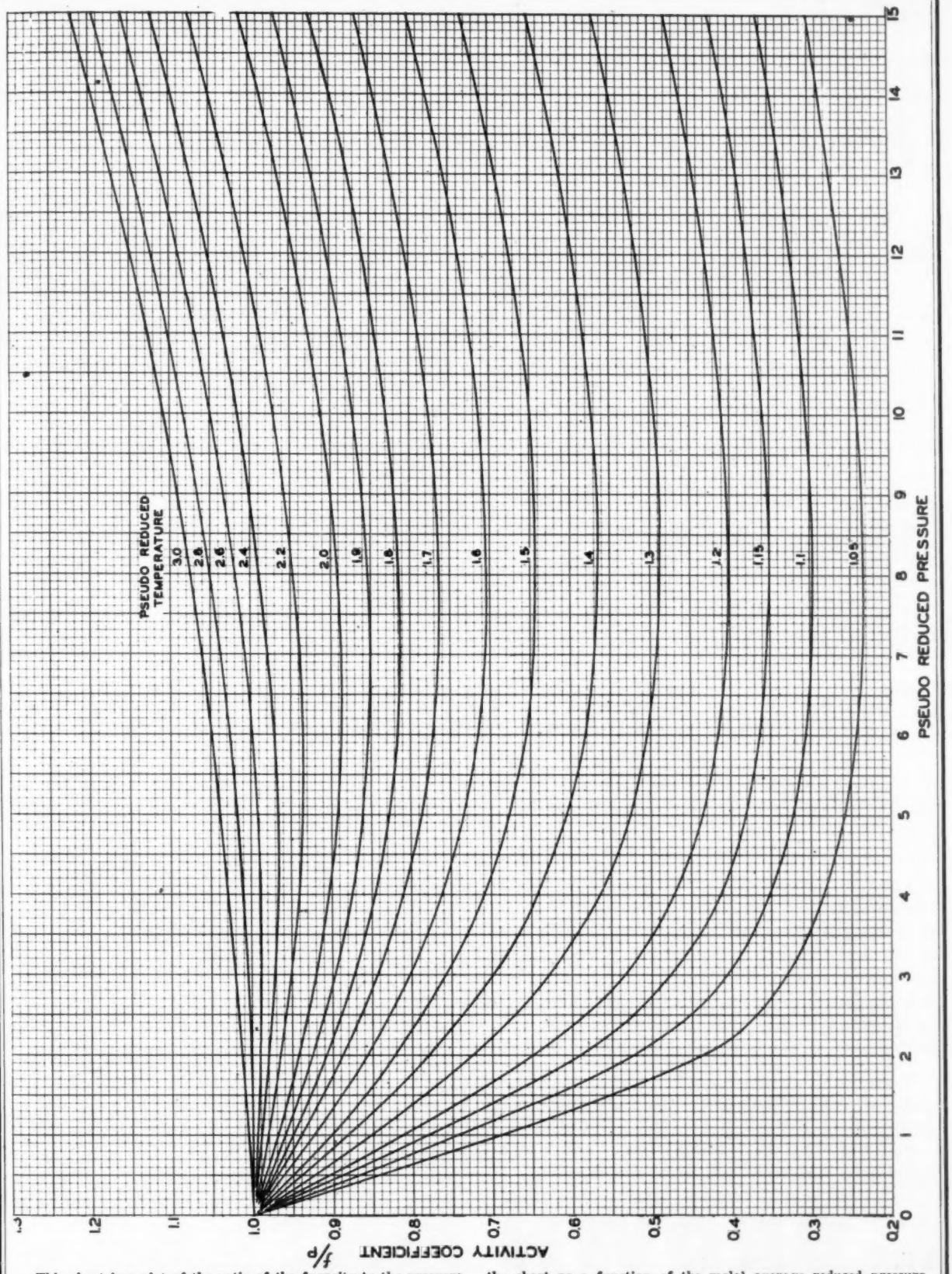
BULLETINS: WH100, WH101 and WH103.

THE MAXIM SILENCER CO. • 90 Homestead Ave., Hartford 5, Conn.

ARMY E NAVY

MAXIM

FUGACITY—PRESSURE RATIO AS A FUNCTION OF PSEUDO REDUCED PRESSURE



This chart is a plot of the ratio of the fugacity to the pressure plotted as a function of pseudo reduced pressure for lines of constant pseudo reduced temperature. The fugacity of any natural gas may then be computed by multiplying the activity coefficient (f/P) by the abs. pressure. The activity coefficient is read from the chart as a function of the molal average reduced pressure (pseudo reduced pressure) or absolute pressure divided by the molal average critical pressure; and the molal average reduced temperature (pseudo reduced temperature) or absolute temperature divided by the molal average critical temperature.

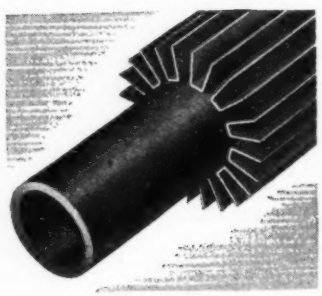
—Chart by George Granger Brown, University of Michigan.

One to Three Weeks Delivery

● In plant after plant,—industry after industry,—and on duty after duty, Brown Fintube Sectional Heat Exchangers are establishing outstanding performance records. They meet every requirement of engineering, operating and maintenance departments.

The new gasketed head seal that avoids lap, gland or ground joints is easily assembled and disassembled with only a standard wrench, thus permitting Brown Fintube sections to be mounted side by side in minimum space. The patented "non-removable" rear end assembly makes inspection and maintenance quick and easy. The resistance-welded integrally bonded fintubes insure trouble-free operation at high thermal efficiency during the entire life of the tube. And then there's unlimited flexibility, too,—the 100% salvage and re-use of existing equipment if the duty should be changed.

If you don't already have full information about the many outstanding exclusive features only Brown Fintube Exchangers can give you, send for a copy of our Bulletin No. 432. It gives full details about the exchangers, —dimensions of the standard sizes,—and contains much other data of interest to engineers and operating men.



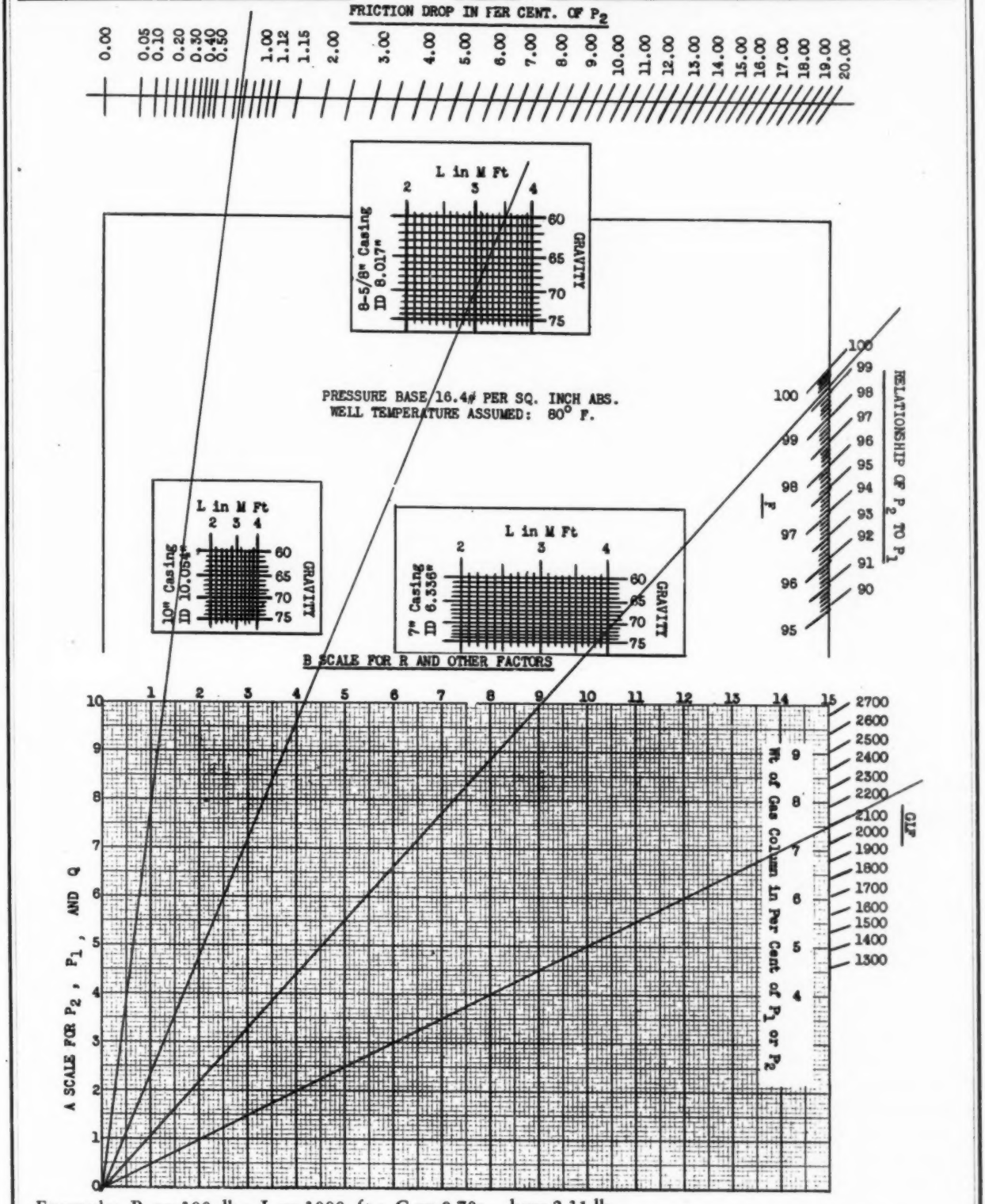
Brown Integrally-Bonded Fintubes are used in all Brown Fintube Heat Exchangers,— are available in Exchangers made by most other manufacturers,— and are ideally suited for many other heating and cooling services. Furnished in plain, "longitudinal," or "cut and twisted" types,— wide range of sizes in low carbon or special steels. Design assistance furnished gladly.

THE BROWN FINTUBE CO.

125 FILBERT STREET • ELYRIA, OHIO

MANUFACTURERS OF INTEGRALLY BONDED FINTUBES AND FINTUBE HEAT EXCHANGERS

BACK PRESSURE OPEN FLOW FACTOR CHART


FRICTION DROP IN PER CENT. OF P_2
0.00 0.05 0.10 0.20 0.30 0.40 0.50 1.00 1.12 1.15 2.00 3.00 4.00 5.00 6.00 7.00 8.00 9.00 10.00 11.00 12.00 13.00 14.00 15.00 16.00 17.00 18.00 19.00 20.00
L in M Ft
8-5/8" Casing ID 8.017"
GRAVITY
PRESSURE BASE 16.4# PER SQ. INCH ABS.
WELL TEMPERATURE ASSUMED: 80° F.
10" Casing ID 10.054"
7" Casing ID 6.336"
RELATIONSHIP OF P_2 TO P_1
F
B SCALE FOR R AND OTHER FACTORS
A SCALE FOR P_2, P_1, AND Q
Wt. of Gas Column in Per Cent of P_1 or P_2
GLF

Example: $P_2 = 300$ lb.; $L = 3000$ ft.; $G = 0.70$; $Q = 9$ MM cu. ft.; casing size = 8.017 I.D. Required: P_s.

Draw line from zero (lower left-hand corner) to intersection of $L = 3$ and $G = 70$ in 8⅝ in. casing box, and read $R = 37.4$ at intersection of $Q = 9$ and drawn line. Draw line from zero through intersection of 37.4 and 300 and read friction drop in per cent of P_2. This is 77/100 per cent. Applying 0.77 to 300 we have 2.31 lb.

$300 + 2.31 = 302.31$ lb. $= P_1$. Dividing $P_2 = 300$ by $P_1 = 302.31$ we have 0.992. At 0.992 on P_2/P_1 scale, read $F = 0.996$. $GFL = 70 \times 3000 \times 0.996 = 2092$. On the GLF scale, the gas column weight is 7.5 per cent of P_1, or 7.5 per cent of 302.31 lb., $302.31 \times 0.075 = 22.67$ lb. $P_s = 302.31 + 22.67 = 324.98$ lb.

—Chart by W. F. Martin, Texoma Natural Gas Company.

It's the Nash!

The ability of Nash Compressors to maintain original performance over long periods is no accident. Nash Compressors have but a single moving element, the Nash Rotor. This rotor is precision balanced for long bearing life, and it revolves in the pump casing without metallic contact. Internal lubrication, frequent cause of gas contamination, is not employed in a Nash. Yet, these simple pumps maintain 75 lbs. pressure in a single stage, and afford capacities to 6 million cu. ft. per day in a single compact structure.

Nash Compressors have no valves, gears, pistons, sliding vanes or other enemies of long life. Compression is secured by an entirely different principle of operation, which offers important advantages often the answer to gas handling problems difficult with ordinary equipment.

Nash Compressors are compact and save space. They run without vibration, and compression is without pulsation. Because there are no internal wearing parts, maintenance is low. Service is assured by a nation-wide network of Engineering Service offices. Write for bulletins now.

No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

Saves floor space.

Desired delivery temperature Automatically maintained.

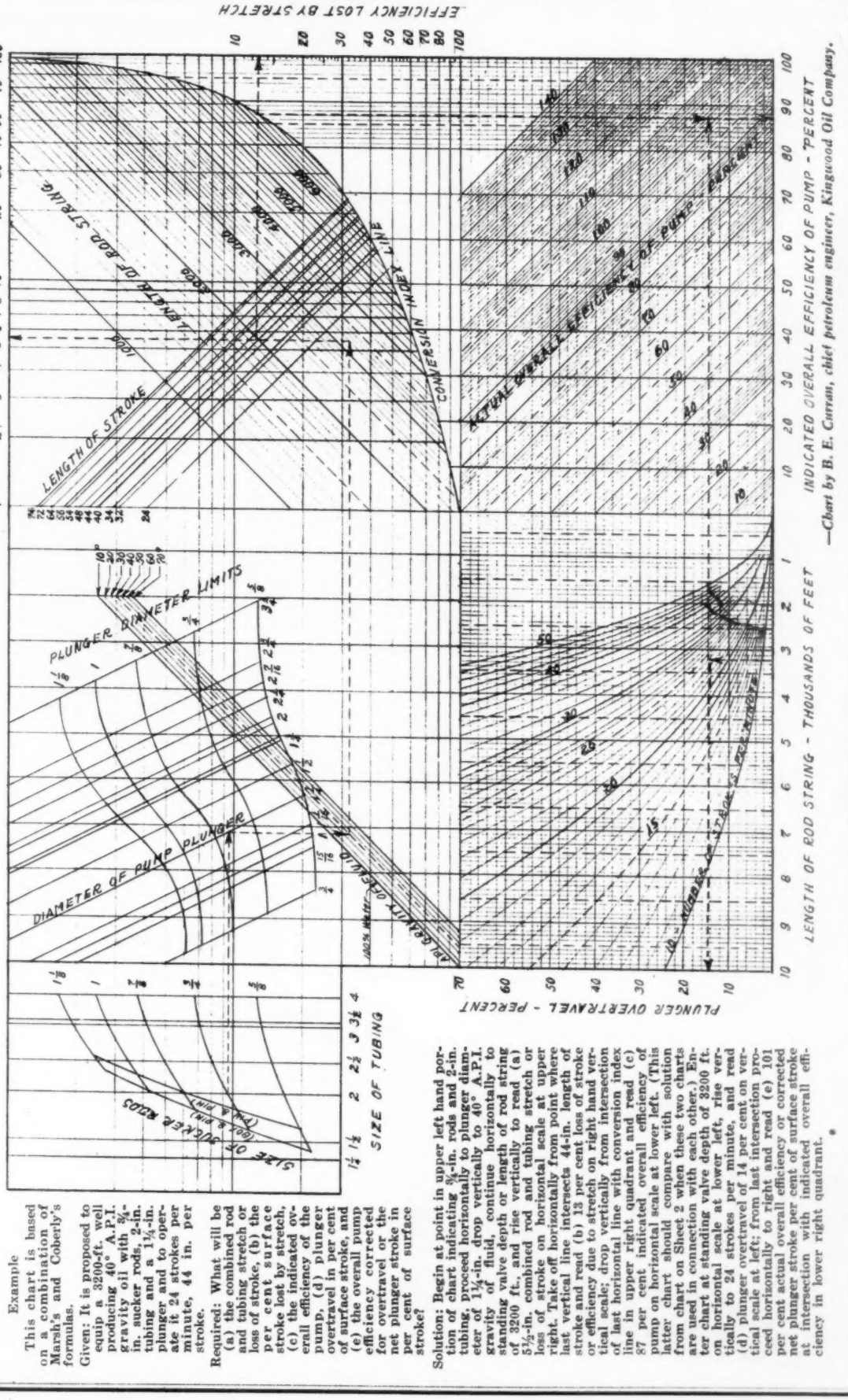
Slugs of liquid entering pump will do no harm.

75 pounds in a single stage.

NASH ENGINEERING COMPANY

283 WILSON, SO. NORWALK, CONN.

LENGTH OF STROKE — ELONGATION — PLUNGER OVERTRAVEL


EFFICIENCY LOST BY STRETCH
COMBINED ROD & TUBING STRETCH - INCHES
LENGTH OF STROKE
LENGTH OF ROD STRING
CONVERSION INDEX LINE
ACTUAL OVERALL EFFICIENCY OF PUMP
PLUNGER DIAMETER LIMITS
DIAMETER OF PUMP PLUNGER
SIZE OF TUBING
SIZE OF SUCKER RODS
PLUNGER OVERTRAVEL - PERCENT
LENGTH OF ROD STRING - THOUSANDS OF FEET
INDICATED OVERALL EFFICIENCY OF PUMP - PERCENT

—Chart by B. E. Curran, chief petroleum engineer, Kingwood Oil Company.

Example

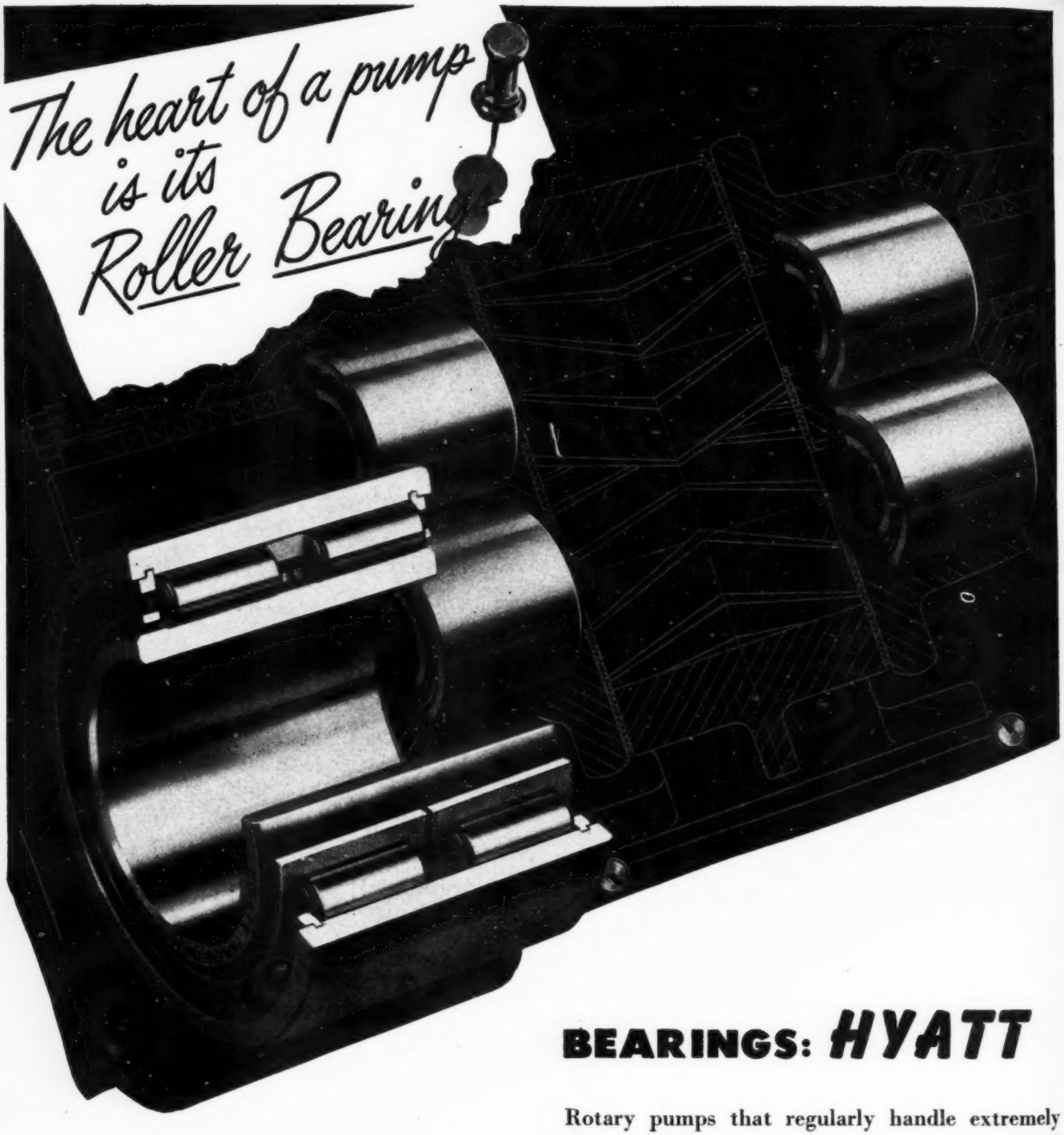
This chart is based on a combination of Marsh's and Coberly's formulas.

Given: It is proposed to equip a 3200-ft. well producing 40° A.P.I. gravity oil with ¾-in. sucker rods, 2-in. tubing and a 1¼-in. plunger and to operate it 24 strokes per minute, 44 in. per stroke.

Required: What will be (a) the combined rod and tubing stretch or loss of stroke, (b) the per cent surface stroke lost by stretch, (c) the indicated overall efficiency of the pump, (d) plunger overtravel in per cent of surface stroke, and (e) the overall pump efficiency corrected for overtravel or the net plunger stroke in per cent of surface stroke?

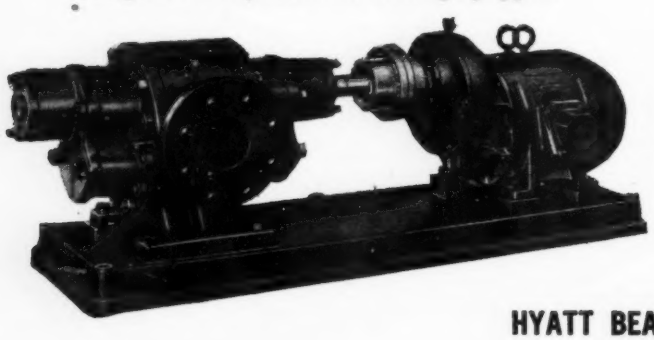
Solution: Begin at point in upper left hand portion of chart indicating ¾-in. rods and 2-in. tubing, proceed horizontally to plunger diameter of 1¼-in. drop vertically to 40° A.P.I. gravity of fluid, continue horizontally to standing valve depth or length of rod string of 3200 ft., and rise vertically to read (a) 5½-in. combined rod and tubing stretch or loss of stroke on horizontal scale at upper right. Take off horizontally from point where last vertical line intersects 44-in. length of stroke and read (b) 13 per cent loss of stroke or efficiency due to stretch on right hand vertical scale; drop vertically from intersection of last horizontal line with conversion index line in upper right quadrant and read (c) 87 per cent indicated overall efficiency of pump on horizontal scale at lower left. (This latter chart should compare with solution from chart on Sheet 2 when these two charts are used in connection with each other.) Enter chart at standing valve depth of 3200 ft. on horizontal scale at lower left, rise vertically to 24 strokes per minute, and read (d) plunger overtravel of 14 per cent on vertical scale at left; from last intersection proceed horizontally to right and read (e) 101 per cent actual overall efficiency or corrected net plunger stroke per cent of surface stroke at intersection with indicated overall efficiency in lower right quadrant.

The heart of a pump is its Roller Bearing



BEARINGS: *HYATT*

Worthington Rotary Pumps with double helical gears are Hyatt Roller Bearing equipped.



Rotary pumps that regularly handle extremely viscous liquids such as tar, molasses, asphalt and rosin, as well as liquids having lubricating value, for top efficiency must have roller bearings of large capacity and long life.

The selection of Hyatt Roller Bearings indicates that the manufacturer has done the utmost to assure the maximum of pump performance.

Whatever your bearing problem may be, call on Hyatt engineers. They bring much valuable help to you.

HYATT BEARINGS Division of GENERAL MOTORS CORPORATION
Harrison, New Jersey

Phillips Opens New Field In the East Texas Area

☆ Promises to be one of most outstanding discoveries since the famous East Texas field—well producing from depth of 9865-9960 ft.

THE Phillips Petroleum Company has completed the discovery well of a new field in Smith County, Texas, approximately five miles south of Tyler, that promises to be one of the most outstanding oil fields since the discovery of the East Texas field in 1930. Completion of the well was made July 4 and is the No. 1 McMinn.

Location of the new strike is 20 miles west of the East Texas field, 20 miles southeast of the Van pool, and 15 miles south of the Hawkins field.

13,000-Acre Block Leased

The well is drilled near the top of the structure on a 13,000-acre block owned by the Phillips Petroleum Company. Additional wells must be drilled to determine the area and thickness of porous oil and gas reservoir; however, company geologists are confident the well has opened up a structure, which was found by subsurface mapping followed by core drilling and seismograph, that substantially increases the company's reserves of oil and gas.

Glen Rose Lime Completion

Production of the well is from the porous Coquina lime of the lower Glen Rose formation drilled between 9865 ft. and 9960 ft. Cores from this section had both odor and stain of oil from 9865 ft. to 9930 ft., a total of 65 ft. of saturated section.

When the well was opened up after being shut down for seven hours for mud conditioning at 8000 ft. a showing of oil occurred. The casinghead pressure of the well built up to 1000 lb. and several barrels of 35-gravity oil and considerable gas were released.

Initial production test of the well was made through a 1/8-in choke from perforations at 9918 ft. to 9929 ft. The well flowed 95 bbl. of 40-gravity yellow-green color crude oil in 12½ hours. Gas-oil ratio was 2800 to 1. Pressure on the tubing was 4600 lb. per sq. in.

Two possible additional productive zones, the Pettit lime and the Travis Peak zone of sands remain to be tested below the present producing level.

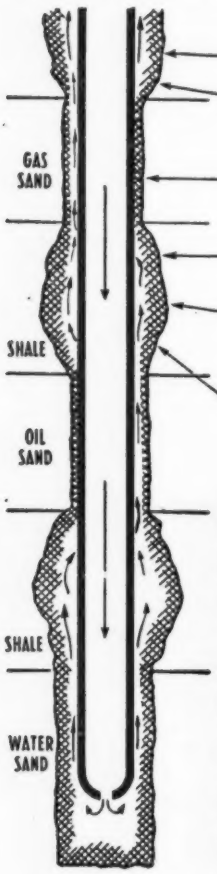
☆☆☆

Christmas tree of the Phillips Petroleum Company's discovery well, No. 1 McMinn, Smith County, Texas. At the left is Leo Recknagel, district engineer, New London office, and at right J. R. Pettigrove, division engineer, Shreveport, Louisiana. Tubinghead gauge on the well reads 4600 lb. per sq. in.

PREVENT
Channeling
WITH

B and W, Inc.

Wall Cleaning Guides



All of these factors are directly responsible for cement channeling.

Placement of B & W Wall Cleaning Guides at 5-foot centers on your casing throughout the productive sand sections, coupled with movement of the casing during the cementing operation, provides good cement CONTACT and a good completion.

BRUCE BARKIS — B and W, Inc. — KENNETH WRIGHT

Well Completion Specialists

WEST COAST: 3545 Cedar Avenue
Long Beach, Calif. • Phone: L. B. 4-8366
GULF COAST: 305 M & M Building
Houston, Texas • Phone: Preston 9783

LAUGH WITH BARNEY

"I'm all done with dames.
They cheat and they lie.
They prey upon us males
To the day that we die.
They tease and torment us
And drive us to sin. . . .
Say—look at that blond
That just came in!"

* * *

Virtues are learned at mother's knee, and vices at some other joint.

* * *

Four marines were playing bridge in a hut on Guadalcanal. Suddenly another leatherneck burst into the room and shouted:

"The Japs are landing a force of about 200 men down on the beach."

The four bridge-player marines looked at one another wearily. Finally, one said: "I'll go. I'm dummy in this hand."

* * *

The husband who knows where his wife keeps her nickels has nothing on the husband who knows where the maid's quarters are.

* * *

The inductee said: "I am descended from Henry Clay on my father's side, and Peter Stuyvesant on my mother's side. My aunt was a Jefferson, and . . ."

"Oh, hell!" said the sergeant, "turn it off. We want you for fighting—not for breeding."

* * *

Grandma (present at photographing of nude baby): Tell me, dear, is it a boy or a girl?

Mother: Surely, you can see?

Grandma: It isn't my eyes that are at fault, dear, it's my memory.

* * *

Youth (at stage door): Is the hula dancer in her dressing room?

Watchman: Son, she's 'round at the rear.

Youth: Yes, I know that, but is she in her room?

* * *

She's so homely that when she passes the Navy yard even the tugboats stop whistling.

* * *

A certain prominent Kentuckian, an enthusiastic imbiber of the more potent spirits of his native state, suffered the loss of his faithful wife. A friend called to offer his sympathy, and was received by the young lady of the house.

"So your poor mother is dead," commiserated the visitor. "And how does your father take it?"

"Oh! straight, as usual, thank you," replied the frank young maiden.

It happened during the rush for gasoline ration coupons, and the scene was an American high school.

The white-haired teacher at the table looked up and grinned at the man standing before her, application in hand.

"Well," she cried; "after all these years, I'm able to give you an 'A'!"

* * *

Sgt.: Between you and me, what do you think of my new girl?

Pvt.: Between you and me, not so good, but alone—oh, boy!

* * *

Judge: Have you a lawyer, Sambo?

Sam: No suh, we'uns decided to tell the truf.

* * *

It isn't ice that makes people slip—it's what they mix with it.

* * *

Gal: Did you ever sell brushes?

GI: No, why?

Gal: Well, you'd better get one and start selling. That's my husband at the front door.

* * *

He: I've got an awful lot of electricity in my hair.

She: I don't doubt it. You always have such shocking things on your mind.

* * *

Husband: Sorry, dear, I won't be home from the office 'til late. I have a form here I must work over.

* * *

"F-e-e-t," the teacher declaimed. "What does that spell, Johnny?"

Johnny did not seem to know.

"What is it that a cow has four of and I have only two?"

The commotion which resulted when Johnny gave his answer left the teacher in a state of embarrassment.

* * *

I didn't know she was a golfer when she asked me to play a round with her.

* * *

He had hard luck fishing, and on his way home he entered the fish market and said to the dealer. "Just stand there and throw me five of the biggest of those trout." "Throw 'em? What for?" asked the dealer in amazement. "So I can tell the family I caught 'em. I may be a poor fisherman, but I'm no liar."

* * *

Sunday school teacher: "Who was the mother of Moses?"

Little Mary: "Pharaoh's daughter."

S. S. T.: "But she only found him on the bullrushes."

L. M.: "That's her story."

As One Oil Man to Another . . .

HOW IS YOUR "I. D."?

(Every day more progressive operators are using the Baker Rotary Casing Scraper to make the inside or "working surface" of their casing clean, smooth and full diameter so that future work will be easy and safe to do.)

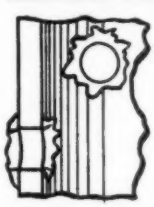
AN OPERATOR SAYS: "We don't consider a well is complete until the casing is scraped smooth and clean."

ANOTHER USER SAYS: "By running the scraper while the equipment is up and the crew is on hand, we leave the casing in smooth, clean condition for future work."

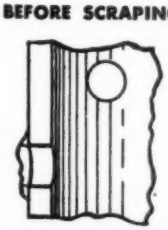
CASING SCRAPER

BAKER OIL TOOLS INC. — BAKER — SERVING THE WORLD

REMOVES BURRS LEFT AFTER GUN PERFORATING



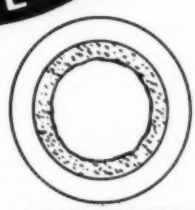
BEFORE SCRAPING



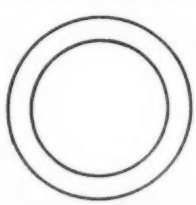
AFTER SCRAPING

RESULTS The sharp burrs left after gun perforating are entirely and easily removed by the Baker Rotary Casing Scraper. Operators figure that the Casing Scraper rental is more than paid for by savings on swab and packer rubbers, and by the elimination of time lost through re-running damaged packers.

CLEANS OUT ALL CEMENT & SCALE



BEFORE SCRAPING

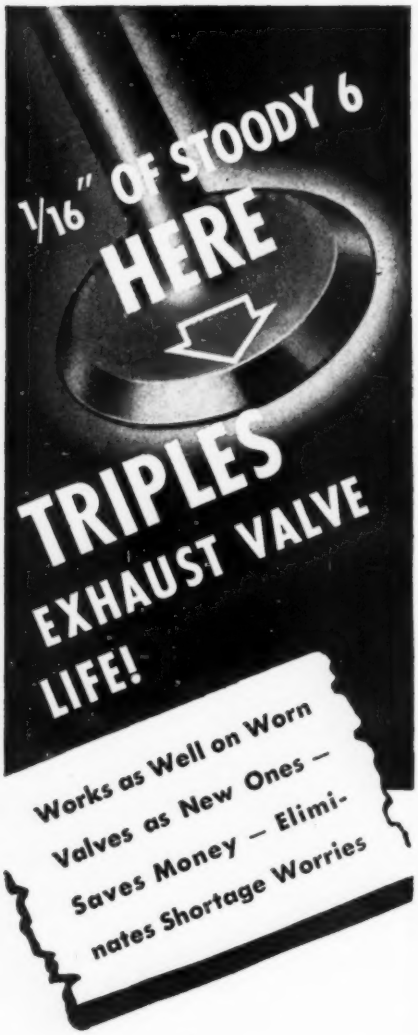


AFTER SCRAPING

RESULTS When running the bit to drill out cement, just make up the Baker Rotary Casing Scraper in the string. The scraper blades clean casing to its FULL I. D.

BAKER OIL TOOLS, INC.

6000 South Boyle Avenue, Los Angeles, California • 6023 Navigation Blvd., Houston, Texas • 312 East Fourth St., Tulsa, Oklahoma • Highway 9 and McBride, Corpus Christi, Texas • 211 Golder St., Odessa, Texas • Longview Highway, Kilgore, Texas • Gretna (Harvey) Louisiana • Highway 90, Scott • 112 W. Main St., Olney, Illinois • Casper, Wyo.


1/16" OF STOODY 6
HERE
TRIPLES
EXHAUST VALVE
LIFE!
Works as Well on Worn Valves as New Ones — Saves Money — Eliminates Shortage Worries

AN ounce or two of Stoody 6 welded to new or worn exhaust valve faces adds 300 to 400 percent to their normal life, prevents burning, saves overhaul jobs, costs only a few cents per valve.

This folder outlines the simple procedure any garage or shop equipped with acetylene welding equipment can follow. Eliminates your worries about valve replacements and saves money as well.

Write for folder "Weld New Life Onto Worn Valves With Stoody 6" — no obligation.

STOODY COMPANY
1142 SLAUSON AVE., WHITTIER, CALIF.

STOODY 6 - THE METAL THAT ADDS EXTRA MILES TO EXHAUST VALVE LIFE!

Running Tour

WITH MEN IN THE INDUSTRY

W. R. LUND, advertising manager of Phillips Petroleum Company, has reported for active duty in the U. S. Navy, where he is a lieutenant, j.g.

F. D. MORGAN joined Lucey Products Corporation in February to manage its heating department. He was formerly associated with Shaw Burner Company as sales manager. Lucey Products Corporation has taken over the exclusive distribution of all Shaw burner products. Both Lucey and Shaw have devoted considerable time to contracting, supervising, and installing heating control equipment. From Tulsa, Morgan will direct sales, service, and installation.

E. CHESTER PEET, formerly assistant treasurer, has become vice president and treasurer of the Shell Oil Company, Inc. CYRUS S. GENTRY, general counsel and secretary, was made a vice president. JOHN M. WATSON, treasurer, is now assistant treasurer of the Shell Union Oil Corporation. The company announced also that WILLIAM H. GARBADE was appointed assistant treasurer to succeed Peet.

VERGIL J. JONES, vice president, cashier and trust officer of the National Bank of Commerce, Tulsa, Oklahoma, has resigned and accepted the position of business manager of Anderson Brothers, pipe line contractors with general headquarters in Tulsa.

WILLIAM F. THIEDE, general superintendent of the Bayonne refinery of Standard Oil Company of New Jersey, has been named assistant manager of that company's New Jersey Works. STANLEY A. WUCHTER, assistant general superintendent of the Bayonne plant, has been made general superintendent, and GEORGE A. ESTY, former process superintendent at the same plant, in turn, succeeds him as the new assistant general superintendent. The New Jersey Works, which includes the Bayonne, Bayway and Eagle operations of the company, is headed by GEORGE H. METTAM, manager.

D. N. GARRISON has accepted a position as chemist with the Great Southern refinery at Corpus Christi, it has been announced. Garrison was associate professor in chemistry at Texas College of Arts and Industries.

D. V. ANDERSON has joined Dowell Incorporated as an engineer at Shreveport, Louisiana. Anderson has been with the Permian Oil Company for the last several years in its production department at Midland, Texas. Dowell has opened a treating station at El Reno, Oklahoma, with V. E. LANG as manager. G. G. MCKENNEY continues in charge of the Dowell office at Guthrie, Oklahoma. A. F. BLUEBAUGH, formerly with the Tulsa Rig and Reel and more recently with the Canol project, is now a treating engineer with Dowell at Seminole, Oklahoma.

M. L. MAYFIELD, petroleum engineer, has been appointed engineer and technical advisor for District 3, Natural Gas and Natural Gasoline Petroleum Industry committee, PAW. The offices of the committee are in Houston, Texas. Mayfield, who has been active in the petroleum engineering field in the South and Southwest for a number of years, was assistant district director of District 3, Natural Gas and Natural Gasoline division.

CECIL D. ROBINSON of McAllen, Texas, was appointed chief geologist for the Coastal Refineries, Inc. He served as district geologist for the Arkansas Fuel Oil Company where he is succeeded by W. W. MCDONALD, geologist for Arkansas Fuel Oil at San Antonio.

BASIL HOPPER and SAM GRINDSFELDER have been elected vice presidents of Union Oil Company of California. ERNEST STAUFFEN, JR., New York, was named a director. Hopper will be in charge of manufacturing and Grinsfelder will direct Union's operations in Texas, Louisiana, Florida, Mississippi, and Alabama.

PHIL J. LEHNHARD, for several years connected with the research department of Dowell Incorporated at Tulsa, and more recently district engineer for Dowell in West Texas, is now associated with United Geophysical Company.

PAUL FITZGERALD of Dowell Incorporated at Tulsa, Oklahoma, has just returned from a six weeks' trip to South America. He visited all the Venezuela oil fields. He made the trip down by way of Miami and came back through Central America and Mexico, stopping off in Mexico for a few days.

THIS ONE IS REALLY SPECIAL!

Another example of Taylor Forge "know-how" that means extra value in WeldELLS

• *They don't come much more special than this fitting: Special material . . . carbon-moly. Special size . . . 9". Special wall thickness . . . 0.542". Special design . . . integrally formed 3" side outlet.*

But special though it is, it is simply typical of the problems that are so frequently put up to us by those who have found that we can solve them right.

Yes, doing the *unusual:* In our regular line of WeldELLS and other Taylor Forge welding fittings we have done the unusual. Into WeldELLS has gone the knowledge acquired in performing just about every conceivable kind of forging operation; knowledge of controlling hot metal under pressure and impact; knowledge that was full-grown long before welding fittings were ever produced on a commercial scale.

This is reflected in WeldELLS in features like extra metal properly distributed where stresses are greatest . . . in the tangents . . . in the extremely accurate dimensions . . . in the features, listed opposite, that are combined in no other welding fittings. Check over this list, and we believe you will agree that

WeldELLS alone combine these features:

- **Seamless** — greater strength and uniformity.
- **Tangents**—keep weld away from zone of highest stress—simplify lining up.
- **Precision quarter-marked ends**—simplify layout and help insure accuracy.
- **Selective reinforcement** — provides uniform strength.
- **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.
- **Wall thickness never less than specification minimum**—assures full strength and long life.
- **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
- **The most complete line of Welding Fittings and Forged Steel Flanges in the World** — insures complete service and undivided responsibility.

WeldELLS have everything

TAYLOR FORGE & PIPE WORKS, General Offices & Works: Chicago, P. O. Box 485
New York Office: 50 Church Street • Philadelphia Office: Broad Street Station Bldg.

MACHINERY and EQUIPMENT

Weld Testing Machine

A NEW portable weld testing machine has been introduced by the Air Reduction Sales Company, manufacturers of gas and arc welding equipment and supplies. Moderately priced, this machine performs these three weld tests: (1) Reduced section transverse tension test; (2) guided bend test (a complete 180° face or root bend); and (3) longitudinal all-weld metal tension test (0.505 in.)

Two outstanding features of this machine are stressed by the manufacturer: First, its ability to provide accurate data on tensile strength and ductility of weld specimens, as determined by the three tests; and second, its relatively light weight, which enables users to perform weld tests right on the job. This latter feature makes the machine particularly useful for firms doing extensive field work such as pipe line installations, construction, and similar jobs performed in remote locations.

An illustrated booklet (ADI-889) describing construction and operation of this new Airco machine may be obtained upon request. Inquiries should be directed to the main office of Air Reduction Sales Company, 60 East 42nd Street, New York 17, N. Y., or to any local Airco office.

New Electrode

A NEW general-purpose electrode for mild steel, designated as "Fleetweld 35," and made specifically for operation on a.c., has just been announced by The Lincoln Electric Company, Cleveland, Ohio.

This new shielded arc electrode, which will also operate on d.c. with either polarity, depending upon the type of work being done, has all the desirable characteristics of the popular Lincoln "Fleetweld" electrodes for high speed welding of single or multiple passes for work in flat, vertical, or overhead positions.

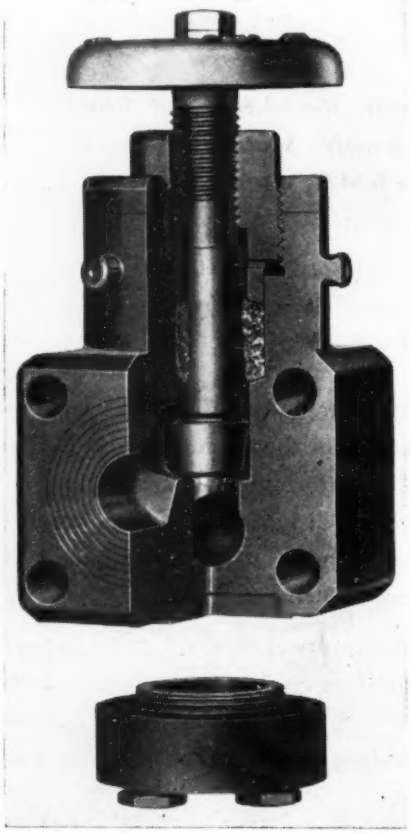
Available in 1/8-in., 5/32-in., and 3/16-in. sizes, "Fleetweld 35" has exceptionally high physical properties, the as-welded weld metal specimens testing as follows:

Tensile strength,
62,000 to 70,000 lb. per sq. in.
Yield strength
52,000 to 57,000 lb. per sq. in.
Ductility (elongation in 2 in.)
23 to 30 per cent

"Fleetweld 35" conforms to American Welding Society specifications for arc welding electrodes classes E-6010 and E-6011, is made in the standard 14-in. lengths, and is packed in 50-lb. containers.

"Karbate" Valves

A "Karbate" globe-type corrosion resistant valve is now being manufactured by the National Carbon Company, Inc. Through addition of the valve to its list of products for the chemical and process industries, National Carbon has made it possible to install complete conveying and heat transfer systems constructed entirely of "Karbate" chemically inert materials.



The new globe-type valves, like "Karbate" tanks, heat exchangers, pipes, fittings, towers, and pumps, are resistant to virtually all corrosive chemicals and are unaffected by extreme thermal shock.

The valves are available in 1-in. and 2-in. sizes. Tested to withstand 50-lb. pressure, they are uniquely small and lightweight, with short face-to-face dimensions. "Karbate" valves are of graphite stock and are self-lubricating. The inert chemical properties of the material prevent corrosion-caused sticking of the moving parts, thereby reducing the maintenance normally required to keep valves operating at full efficiency.

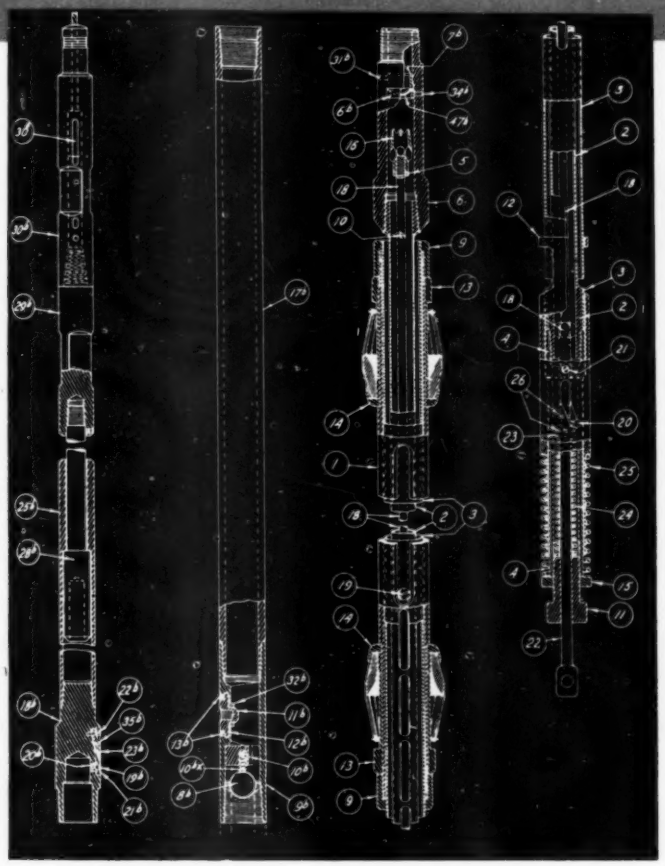
"Karbate" valves are equipped with adapter plugs for steam heating those fluids that tend to crystallize or solidify when handled through unheated lines. Utilization of the adapter plugs for steam heating the valve will prevent clogging and avoid shut-downs while valves are being dismantled and cleaned.

Non-Spin Safety Mud Gun

The heavy duty mud gun shown in the accompanying illustration, made of cast steel, is a high pressure type. The gun is equipped with extra large packing glands and Alemite fittings. It locks both vertically and horizontally. As the center line of the discharge passes through the inlet there is no tendency to spin.

An important feature is the rubber lined nozzle, made of Patterson-Ballagh PBX synthetic rubber, especially compounded to resist oil. This nozzle has been standard equipment on Patterson-Ballagh mud guns for many years. Actual field use indicates this nozzle to develop minimum back pressure and to hold to gauge longer than the metal formerly used.

GRANT



Hydrostatic

PERFORATION CLEANER

Sluggish wells cleaned with the GRANT Hydrostatic Perforation Cleaner are put in the best condition to produce oil more freely because the GRANT Cleaner not only breaks up clogging materials but also removes them from the well completely. Increased production generally lasts for a considerable time before cleaning is again necessary. Non-producing wells have frequently been made to pay by using the GRANT Cleaner alone.

This GRANT Tool is run on the wire line and works fast. Unloading at the surface and replacing the *exclusive* GRANT composition disc requires but a few moments.

The GRANT Hydrostatic Perforation Cleaner is a product of many years of experience and has been successfully used in oil fields throughout the world.

Mail coupon below for detailed information about this and other GRANT Tools.

1. Cup Assembly
2. Main Tube
3. Bypass Cover Tube.
4. Latch Sleeve.
5. Disc Breaker Head Lock Nut.
6. Disc Holder Section.
9. Cup Assembly Nut.
10. Main Tube Sub Lock Screw.
11. Spring Adjusting Screw.
12. Tripping Sleeve.
13. Cup Sleeve.
14. Cup Thimbles.
15. Spring Adj. Screw Lock Nut.
16. Disc Breaker Head.
18. Disc Breaker Rod.
19. Cup Assembly Body Guide Studs.
20. Latch Bolt.
21. Tripping Sleeve Guide Studs.
22. Latch Setting Rod.
23. Latch Setting Rod Lock Nut.
24. Disc Breaker Spring.
25. Tripping Sleeve Spring
26. Latch Bolt Lock Washers.
6b. Disc Holder.
7b. Disc Seat Bushing with Packing Ring.
8b. Steel Check Ball.
9b. Unloading Chamber.
10b. Check Ball Stop.
10bx Check Ball Stop Spring.
11b. Unloading Door.
12b. Unloading Door Gasket.
13b. Unloading Door Set Screw.
17b. Loading Chambers.
18b. Loading Chamber Head.
19b. Relief Valve Ball.
20b. Relief Valve Seat Bushing with Copper Washer.
21b. Relief Valve Spring.
22b. Relief Valve Screw with Lock Washer.
23b. Relief Valve Spring Stop.
25b. Jar Anvil Coupling.
28b. Jar Mandrel.
29b. Jar Mandrel Tool Joint with Lock Screw.
30b. Rope Socket.
30a. Rope Socket Sleeve.
31b. Disc Seat Bushing Lock Screw.
32b. Unloading Door Gasket Nut.
34b. Disc Holder Lock Screw.
35b. Relief Valve Adj. Screw.
47b. Sealing Disc.

CHECK AND MAIL TODAY!

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2042 EAST VERNON AVENUE,
LOS ANGELES 11, CALIFORNIA.

Please send me, without obligation, complete information on the GRANT Tools checked below.

NAME..... TITLE.....

COMPANY .....

ADDRESS.....

CITY..... STATE.....

☐ Bailers ☐ Cleaners ☐ Hole Enlargers ☐ Liner Pullers
☐ Reamers ☐ Shale Bits ☐ Underreamers ☐ Wall Scrapers

GRANT OIL TOOL CO.

2042 EAST VERNON AVENUE • LOS ANGELES 11, CALIFORNIA

BRANCHES:

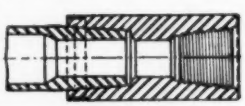
AVENAL • BAKERSFIELD • SANTA MARIA • VENTURA

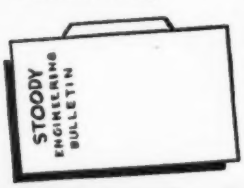
Doubles tool joint life

For fifteen years Tube Borium has been used on drilling bits to increase cutting speeds and drill more out-to-gauge hole. Now you can use this same alloy to greatly prolong the life of your tool joints!

An exceedingly small quantity of Tube Borium welded in a ring around the shoulder not only doubles tool joint life—even under the toughest operating conditions—but maintains over all joint strength and correct elevator contour. Applications are economically made on both new and resleeved joints.

APPLICATION: Accepted method of application is to under-cut new or resleeved joints at the shoulder to form a recess ⅛" deep by 1½" wide. The recess is then filled by welding in with 3/16" Electric Tube Borium to form the wear resistant inlay.





Write for this special Stoody engineering bulletin describing in detail hard-facing procedures on tool joints—no obligation.

STOODY COMPANY
1142 WEST SLAUSON, WHITTIER, CALIF.

STOODY HARD-FACING ALLOYS
Retard wear... Save Repair

Lane-Wells Promotions

Continued growth and diversification of the business of Lane-Wells Company has necessitated a number of changes in the company's executive staff, according to W. T. Wells, chairman, and Rodney S. Durkee, president.

M. E. Montrose has been made vice president and manager of services and sales. He will direct the activities of the oil field divisions, and head office, export, and industrial sales. Montrose entered Lane-Wells employ in 1935 and, after serving as manager of both the Mid-Continent and Gulf Coast divisions of the company, was made vice president and general sales manager in 1939.

M. E. MONTROSE

Norman L. Dorn, vice president and chief engineer, will continue to head the engineering department and will be responsible for the design and development of all equipment and products.

Dr. Russell M. Otis has been advanced to the position of manager of research and will manage the activities of the research department under the direction of Wells. Dr. Otis will also handle all patent matters.

Harvey L. Ballough, for many years associated with Douglas Aircraft Company and, lately, with Goodyear Aircraft Corporation, has joined Lane-Wells as executive assistant to the president. In addition to assisting the president in the coordination of the operations of all departments, Ballough will direct the activities of the newly established industrial relations department.

Captain D. S. Jeppson has been released from service in the U. S. Marine Corps and has rejoined the company in his former capacity of director and controller.

Increasing Capacity

Developments now in progress at the National Supply Company's Toledo, Ohio, plant will double present capacity for the manufacture of tool joints for the oil industry, and also will provide facilities for production of oil well rotary drilling equipment. Up to this time, National Supply's production of rotary drilling machinery has been confined to the company's Torrance, California, plant.

According to C. R. Barton, vice president in charge of manufacturing, the doubled facilities for tool joints will be ready by October, and full production of drilling machinery should be reached by January.

Manager of Stores

The appointment of Herschel Lewis as manager of stores, D+B Mid-Continent division, has recently been announced by the D+B Division of Emsco Derrick and Equipment Company.

H. LEWIS

Lewis has a broad background in the petroleum industry having spent nine years with the Gulf Oil Company, Gypsy Division, in both field and office operations. In 1937, he became associated with Lamtex Equipment Corporation of Fort Worth and was in active charge of the management of installation, servicing, and sales of Lamtex pumping equipment until his recent association with D+B.

Promotions Made

At a recent directors' meeting of The Marley Company, Inc., cooling tower manufacturers, Ray T. Jenkins and Joseph A. Cameron were elevated to vice presidencies. Jenkins, now general sales manager at the main offices in Kansas City, Kansas, is succeeded as director of the company's Houston division by Joe T. McKinley. Cameron continues in charge of the Eastern Seaboard division with offices at 2 Rector Street, New York City.

J. A. CAMERON R. T. JENKINS

On Extended Trip

J. A. ENGSTRAND

J. A. Engstrand left Los Angeles the latter part of June on an extended trip in the interests of the Grant Oil Tool Company. Engstrand, traveling by air, will first visit Chicago, Washington, New York, and Florida, then fly to Trinidad, Equador, Peru, Venezuela, Colombia, and Brazil.

Nunley Transferred

The Oil Tool Division of Byron Jackson Company announces the transfer of Barney A. Nunley from Alice, to Odessa, Texas. Nunley originally joined Byron Jackson Company on being honorably discharged from service in the United States Army, after which he spent several months in intensive shop training at the BJ main plant. From there he entered the sales and service organization in Southwest Texas.

Prior to entering the army, Nunley spent several years in the oil fields, working as roughneck, driller, and toolpusher.

West Texas Manager

John Prichard has been appointed district manager in charge of West Texas operations by Kobe, Incorporated, manufacturers of the Kobe hydraulic pumping system, Huntington Park, California.

JOHN PRICHARD

Prichard, who will make his headquarters at Odessa, is a graduate of the University of Oklahoma and joined the Kobe organization in 1940. He was advanced to district representative in Oklahoma City in 1941 and a year later was transferred to Illinois as Kobe's district manager for that area. In 1943 he held the same position in the company's Kansas-Nebraska territory where he remained in charge of operations until his new appointment to the West Texas managership.

Sales Manager

F. L. Prosser has been appointed as Mid-Continent sales manager of the D+B Division, Emsco Derrick and Equipment Company.

F. L. PROSSER

Prosser brings to his new position a wide background of experience in the petroleum industry dating back to the Roxana Petroleum Corporation, now Shell Oil Company, Inc., at Tonkawa, Oklahoma, in 1923. He was later transferred to Seminole, Oklahoma, where he spent several years as office manager and manager of warehouses in that area before Shell moved him to field operations as production foreman for that locality, and later for the McPherson, Kansas, area. In 1936, he joined the Emsco Derrick and Equipment Company and was assigned the South Texas and Gulf Coast territory where he was instrumental in the installation of the first Mid-Continent field service stores for that territory. For the last two years, he has been manager of field stores for the D+B Division, making his headquarters in Dallas.

Production Can Get in a Rut

All pumping devices with walking beams must look alike to laymen. . . . Sometimes we think they look alike to producers.

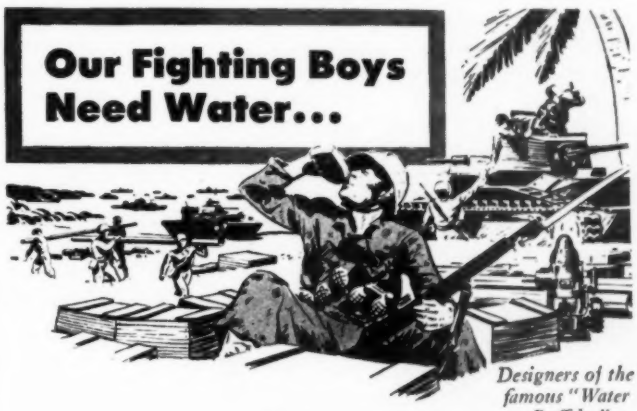
Any well is likely to be more profitable and satisfactory when equipped with a JENSEN Unit, but it often takes a lot of persistence to get a producer to check that statement.

Why don't you? Talk with owners. Ask dealers. See our Composite Catalog pages. Write us for Bulletin No. 27.

JENSEN
BROTHERS MFG. CO.
Coffeyville, Kansas, U. S. A.

Export Office: 50 CHURCH STREET, NEW YORK CITY

Our Fighting Boys Need Water...



Designers of the famous "Water Buffalos"

IT TAKES a lot of things, like bullets, bombs, bayonets, bazookas—and *water*, to win a war. Cool, fresh drinkable water in abundance. *Peerless Pumps* at the fighting fronts keep canteens filled—and keep our fighting men fit!

Now that we are meeting the tremendous war-front demand for Pumps, we hope to be able to start "digging in" on our huge backlog of orders for home needs.

PEERLESS PUMP DIVISION—*Food Machinery Corporation*
1250 Camden Ave., S.W. Canton 6, O.; 301 W. Ave. 26, Los Angeles 31, Cal.
OTHER FACTORIES: Fresno 16, San Jose 5, California

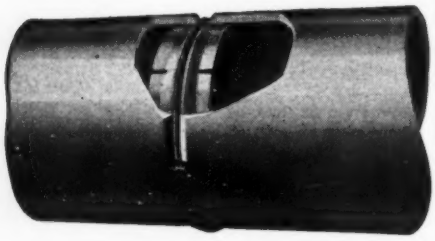
PEERLESS
Deep Well Pumps...

any PIPE WELDING is done . . .

CHEAPER and BETTER

WITH WEDGE Split CHILL RINGS

On any pipe welding job—for refinery or pipe lines, you can use WEDGE Chill Rings with the Patented SPLIT Feature to everlasting advantage. Formerly the weak parts of a welded pipe line were the joints—but NOW the joints are the STRONGEST part of the line. WEDGE Chill Rings reinforce the joints and assure 100% PENETRATION. In case of shock, strain or vibration the pipe will fail before the reinforced joints. Use WEDGE Chill Rings NOW and avoid future trouble. The cost is easily offset by greater speed in welding. You can lay the line FASTER and BETTER with less skilled help and skilled help can do much better.



Write for Information

WEDGE PROTECTORS, INC.

9522 Richmond Avenue Cleveland 5, Ohio

WEDGE Split CHILL RINGS SAVE MONEY

Dr. Egloff Honored

Dr. Gustav Egloff, director of research of Universal Oil Products Company, and president of the American Institute of Chemists, recently received the degree of Doctor of Science, honoris causa, from the Philadelphia College of Pharmacy and Science, in Philadelphia.

DR. EGLOFF

Dr. Egloff was selected for this honor, according to Dr. Ivor Griffith, president of the college, "for outstanding contributions to science and technology of petroleum."

The degree was conferred at the commencement exercises of the college June 28.

Personnel Changes

H. Boezinger, vice president, Merco Nordstrom Valve Company, and district manager, Pittsburgh Equitable Meter Company, announces the following changes in their Pacific Coast office.

E. H. "Ernie" Adams has been appointed assistant district manager and will operate out of the Pacific Coast district office at Los Angeles.

R. L. Ford, formerly in the Seattle office, has been transferred to the Los Angeles district office where he will handle the sale of water meters in southern California.

Gilbert Bowman has been placed in charge of the San Francisco office. Frank Tangney, formerly with the National Meter Company, which was acquired in 1914 by Pittsburgh Equitable Meter Company, has been placed in charge of Pittsburgh Equitable's Seattle office. Sales headquarters for the Pacific Coast of both Merco Nordstrom Valve Company and Pittsburgh Equitable Meter Company are at Los Angeles.

The simplest gas mixing valve built. Thousands in use on pumping wells throughout the oil fields. Increased allotments of material will make them available to supply all demands in the near future.

J. & S. CARBURETOR CO.

2634 North Beckley

DALLAS 2, TEXAS

FOR A GOOD, HONEST WATER CONDITIONING JOB . . . LARGE OR SMALL

Call

JOHN FIELD-MAN

ON YOUR NEXT WATER CONDITIONING JOB

LELAND HAMNER CO.

P. O. Box 1065 - Capitol 9758 - Long Distance LD 2175

2211 PRESTON AVE. HOUSTON, TEXAS

Drilling superintendent wants working interest in a rig or rigs for looking after same. Fifteen years on rotary rigs in all of the Mid-Continent area, also Illinois and Canada. Nine years as drilling superintendent and contact man for successful drilling contractors. Have good knowledge of all phases of the drilling contracting business. Can give the best of character and experience references. Address Box 15, % The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

Dresser Industries Acquire International-Stacey Corp.

Dresser Industries will acquire financial control of International-Stacey Corp. of Columbus, Ohio, and subsidiaries in a step designed "to enlarge postwar participation in oil-field equipment potentials," H. N. Mallon, president of Dresser has disclosed.

The announcement followed a meeting of International-Stacey directors in Columbus approving the transaction. Dresser directors, meeting in New York on June 23, had previously signified approval.

Dresser and International-Stacey stockholders will be asked to ratify the agreement in special meetings to be called soon. No changes in management or personnel of International-Stacey companies are involved or contemplated, Mallon said.

International-Stacey and subsidiaries, a group of six companies, is a leading manufacturer of oil-field drilling and production equipment sold under the trade name "Ideco." Dresser Industries, with seven companies in its group, supplies related equipment to the oil industry.

Dresser Industries include Dresser Manufacturing Company, Bradford, Pennsylvania; Clark Brothers Company, Olean, New York; Bryant Heater Company, Cleveland, Ohio; Pacific Pump Works, Huntington Park, California; Bovaird and Seyfang Manufacturing Company, Bradford, Pennsylvania; Van der Horst Corp. of America, Olean and Cleveland, and Dresser Manufacturing Company, Ltd., Toronto, Canada.

In the International-Stacey group are International-Stacey Corp., with plants in Columbus, Delaware, and Marietta, Ohio; International Derrick and Equipment Company of Texas, Beaumont; International Derrick and Equipment Company of California, Torrance; International Derrick and Equipment Company of Ohio, Columbus; Roots-Connersville Blower Corporation, Connersville, Indiana, and Stacey Bros. Gas Construction Company, Cincinnati, Ohio.

WANTED
PIPING DRAFTSMAN

Experienced in the design and detailing of pressure piping such as oil refinery, power plant or chemical plant piping. High priority war work with independent refiner having long record of full capacity operation and uninterrupted employment. Applicants must comply with War Manpower Commission regulations. Reply Box 12, % The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

Rough and Ready

DEMANDS READY AND RAPID SERVICE

Clearing projects in the petroleum industry, whether to make way for a pipe line or a drilling rig, call for efficient, dependable equipment. Careful planning is all-important to keep the job on schedule. Lengthy delays for service must be avoided.

When track repairs are needed on tractors and bulldozers, a Rodgers Track Press means hours instead of days to do the job. Rodgers Presses have been tested and proved on the job . . . . Among petroleum engineers their reputation for dependable service is established. And these Presses are available *now* on priority.

HYDRAULICS Rodgers KEEP THE WORLD MOVING

Manufacturers of:
UNIVERSAL HYDRAULIC PRESSES
TRACK PRESS EQUIPMENT
HYDRAULIC KEEL BENDERS
HYDROSTATIC TEST UNITS
POWER TRACK WRENCHES
HYDRAULIC PLASTIC PRESSES
PORTABLE STRAIGHTENER FOR PIPE AND KELLYS

If it's a Rodgers, it's the best in Hydraulics. Rodgers Hydraulic Inc., St. Louis Park, Minneapolis 16, Minnesota.

Where hydraulic power is needed for pressing, pulling and lifting, write for information about the Rodgers Universal Presses. Both portable and stationary models with varying capacities.

Rodgers
HYDRAULIC Inc.

Ready to Remove
and Prevent
Scale and Corrosion
in Boilers and Tubes

SAND-BANUM

Comes Ready to Use as Is. Its Action is Automatic

GUARANTEED harmless to personnel and equipment

"The Entirely Different Boiler and Engine Treatment"

There is no obligation in writing for data, and details of test on the basis of NO cost, unless absolutely satisfied.

AMERICAN SAND-BANUM COMPANY, Inc.

9 Rockefeller Plaza, New York City 20

Stocks carried by
WESTERN SAND-BANUM COMPANY
Houston, Texas
and at other convenient points including leading supply houses

Export Representatives
PETROLEUM MACHINERY CORP.
30 Rockefeller Plaza New York City 20

For QUICK, ACCURATE TESTS
Use CURTIN CENTRIFUGES

No. 3420 15 c.c. machine . . . . Cranks and heads interchangeable with 100 c.c. machines.

Simple in design . . . Ruggedly built . . . Require no special care . . . Great Ratio and throw of crank produce required speed with no strain. Curtin Centrifuges meet all A.S.T.M. *Standard Method D-96-40* and *A.P.I. Code No. 25* requirements. Fully descriptive literature upon request.

W·H·CURTIN & CO. Inc
HOUSTON TEXAS

National Carbon Changes

A new sales set-up under which all company products will be handled nationally from seven divisional offices is being installed by National Carbon Company, Inc., it is announced. Four of the new offices are in operation and the others will be added by October 1.

All sales activities in the Southeast have been consolidated under a new Atlanta division office. This division will comprise, in addition to Georgia, the states of Virginia, North and South Carolina, Alabama, most of Tennessee, and Florida. J. F. Warnell, former manager under the "district" system and recently stationed at New York, has returned to Atlanta as division manager. The assistant manager is C. J. Chapman, who has been in company sales for the last 10 years, and W. R. Peppard is office supervisor. The organization is using the former district address, 41 Marietta Street, Atlanta 3.

C. C. Joslyn is manager of the new Dallas, Texas, division. He has been with the company more than a decade. Assistant manager is J. L. Mullen, recently district manager at Atlanta, and J. F. Uhl is office supervisor. The former district offices at 200 South Ervay Street, Zone 1, have been retained. This division will comprise, in addition to Texas, the states of Arkansas, Oklahoma, New Mexico, Mississippi, Louisiana, and part of Tennessee.

At Kansas City, A. C. Bryan has taken over as division manager. He has been with the company for ten years as salesman and sales executive. E. L. Dibble, former manager of the district there is assistant manager. C. H. Wade is supervisor of the new offices, which occupy the same location, 19th and Campbell Streets, Kansas City 8. The division will comprise, in addition to Missouri, the states of Kansas, South Dakota, Wyoming, Nebraska, Colorado, Western Illinois, and most of Iowa.

On the West Coast, R. P. Tolles, manager of the former Pacific Coast Division, succeeds to the direction of the new San Francisco organization. The assistant managers are A. R. Miller, former district manager at Portland, Oregon, and O. B. Rendahl. The new division staff will occupy the old address at 114 Sansome Street, San Francisco 4, and from this headquarters will be directed sales in California, Washington, Oregon, Western Montana, Idaho, Utah, Arizona, and Nevada.

The three division offices yet to be opened will be located at Chicago, Pittsburgh, and New York. Enlarged staffs will be active in all divisional headquarters, with the personnel made up of specialists and salesmen of long experience in all National Carbon lines.

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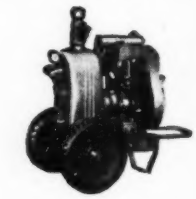

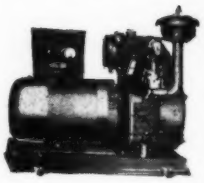

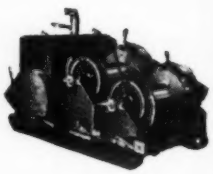

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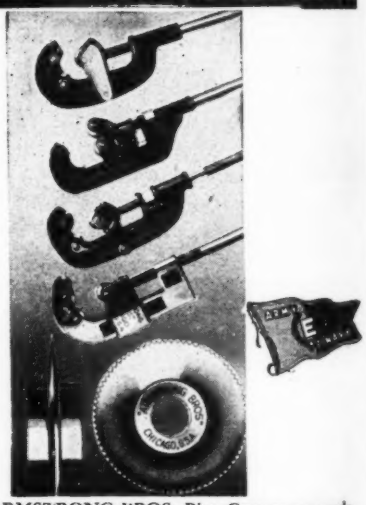

All ARMSTRONG BROS. Pipe Cutters are made in all standard types. Each is a quality tool with hardened steel pins and rollers. "Saunder Type"—hardened end of thrust rod bears on inserted hard steel block (double life). In "Drop Forged" and "Combination" types, which take either 1 or 3 wheels, a replaceable hardened steel nut takes up thrust. In the "Barnes" type thrust rod threads through drop forged steel section.
ARMSTRONG BROS. Knife Blade Cutter Wheels (smooth or knurled) have thin penetrating edges that hold their keenness because they are machines from special vanadium tool steel, hardened and oil tempered. Fit all standard-make pipe cutters. . . . *Write for Catalog C-39a.*

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Bethlehem Promotions

H. H. Fuller has been elected vice president in charge of West Coast steel activities of Bethlehem Steel Company, E. G. Grace, president, announces.

Fuller succeeds W. H. Stewart who has held the office for the last 12 years. Stewart, though retiring from active duty, will continue in an advisory and consulting capacity.

Fuller entered the employ of Bethlehem at the close of the First World War. In 1936 he became assistant manager of sales for the New York district and two years later was appointed district sales manager.

Other appointments as follows have been announced by Paul Mackall, vice president in charge of sales.

C. M. Mackall will succeed Fuller as manager of sales, New York district.

Mackall goes to New York from Pittsburgh, Pennsylvania, where he was general manager of central sales.

Bennett C. Macgregor, formerly manager of sales, St. Louis district, will succeed Mackall.

C. H. Cecil has been named to succeed Macgregor as manager of sales at St. Louis, coming to this position from the sales force in the Chicago district.

Opens Branch Office

H. B. WILDER

Combining the demands of wartime production activities in the oil and chemical industries with the needs of "pre-postwar" expansion planning, the J. B. Beaird Company of Shreveport, manufacturers of oil and chemical production and processing equipment, announces the opening of a branch sales and service office at 305 Citizens State Bank Building, Houston, Texas.

The Houston office will be under the management of Hubert B. Wilder, who will handle sales work and expedite service.

Wanted—Petroleum Engineers and Geologists

...with field experience. Excellent opportunity with major oil company operating in Venezuela. Permanent positions. Engineers should be experienced in well completion practice and equipment. Mud control experience valuable. Give age, educational background, experience and marital status to Box 10, % The Petroleum Engineer, P. O. Box 1589, Dallas, Texas.

SHAKING TROUBLE OUT OF A TEXAS WILDCAT . . .

Shale and other damaging cuttings picked up in drilling mud, are a source of no small problem, cluttering up slush pumps and rotary hose and breaking up the consistency of the mud. Tons of this natural nuisance are circulated out of many extremely deep holes. The Link-Belt Mud Screen pioneered the job of ridding otherwise safe, efficient drilling mud of this trouble-maker, and operators the world over accept it as the No. 1 method of reconditioning rotary drilling fluid. Pictured here is a Link-Belt Type NRM-124 Dual Mud Screen, driven by a single turbine (or electric motor) and operated either singly or as a dual unit, according to fluid load requirements. Send for folder 1872-A.

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Philadelphia 40, Dallas 1, Houston 2, Los Angeles 33, New York 7, Toronto 8.

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There's more to babbitting connecting rod bearings than simply applying the metal. Not only must the work be expertly done, but it is important that frequent detailed chemical analyses be made of materials in order to provide a dependable safeguard against inferior quality bearing metal, and to assure constant uniformity.

Wisconsin Engine connecting rod bearings are babbitted in our own plant, under our own complete control. A careful check is maintained to make sure that the metal is always what it *should* be and that it is applied *the way it should be*. This helps to make a better engine . . . designed to give better service on your equipment.

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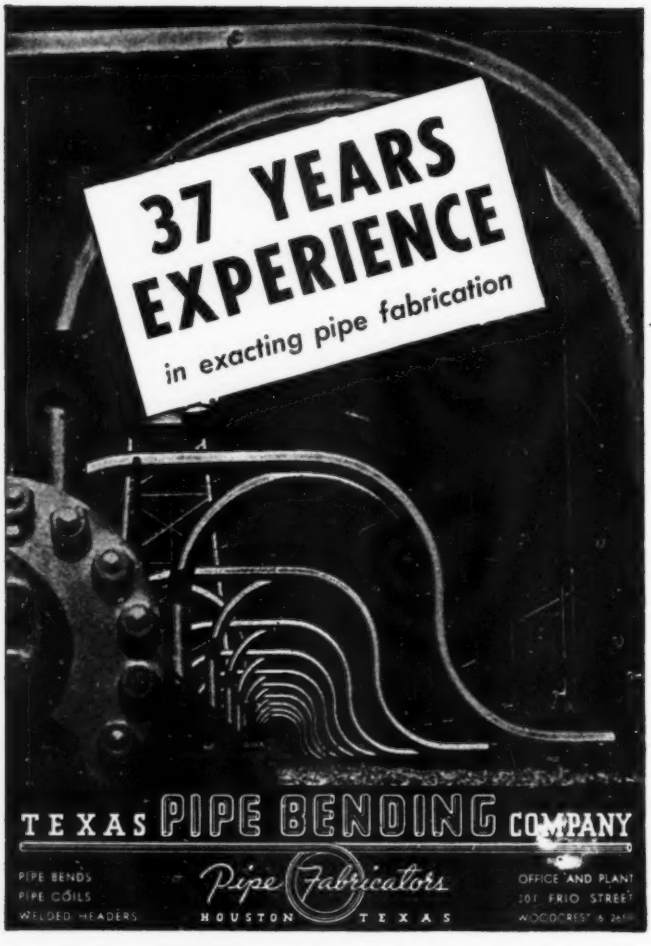

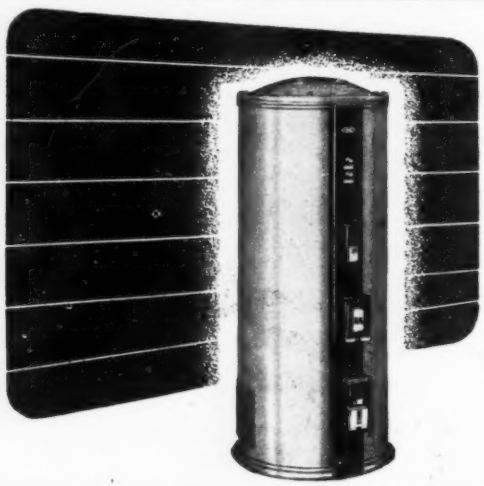

THE ADVANCED ENGINEERING AND DESIGN of Honan-Crane "Continuous" Oil Purifiers will give maximum protection for any Diesel engines or compressors under any kind of operating conditions. Honan-Crane "Continuous" Oil Purifiers accomplish thorough purification by removing all types of contamination as fast as they are liberated in the oil. Your engine is lubricated by a constant supply of clean oil.

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TRADE LITERATURE

What to Write For

"DIRECTIONAL REDRILLING OF PIERCEMENT TYPE DOME TO INCREASE RECOVERY" is the title of an article now in reprint form that is available through Sperry-Sun Well Surveying Company. Write the company at 1608 Walnut Street, Philadelphia, Pennsylvania, for a copy if you are interested in increasing recovery from piercement type domes.

SPECIAL LITERATURE may be obtained from Grant Oil Tool Company, 2042 East Vernon Avenue, Los Angeles 11, California, on any Grant tools. Information is brought up to date and the latest data on modern Grant tools can be found in the booklets.

GENERAL ELECTRIC COMPANY, Schenectady, New York, has published a new booklet, GEA-4214, on Electronic Relay. A description of the GE control CR7511-A and drawings of its uses are graphically presented. Copies are available.

FLOW CHARTS and discussions of repressuring, pressure maintenance, and oil conservation are the subject of a 12-page booklet published by Clark Brothers Co., Inc., Olean, New York. Photographs of Clark compressors in various plants are reproduced.

Smith to South America

The Oil Tool Division of Bryon Jackson Company announces the departure of Jack Smith for a visit to the oil producing countries of South and Central America. Smith will visit the countries of Mexico, Venezuela, Ecuador, Peru, Colombia, and Trinidad, B.W.I., in the interest of the new BJ products and in the general use and engineering of the BJ Elliott wire line core barrel.

Rejoins Youngstown

J. W. OWINGS

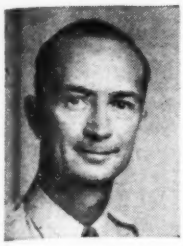
Announcement has been made of the resignation of Jay W. Owings, deputy chief, pipe branch, steel division, War Production Board, for the last 2 years, to rejoin The Youngstown Sheet and Tube Company as assistant manager of tubular sales.

Owings was with The Youngstown Sheet and Tube Company for 14 years before joining WPB, spending 8 years in the metallurgical department and 6 in field service.

J & L Appointment

The Jones & Laughlin Supply Company announces the appointment of Seymour S. Baker as district representative of the engineering and construction division, for the Gulf Coast area. He will be located in Houston and will serve the coastal area from that point. The appointment of Baker will make the services of the company more readily available to the refinery and natural gasoline industry in this territory.

New HOMCO Store



W. K. MILLS

L. L. TALLEY

H. J. MOON

Houston Oilfield Material Company announces the opening of a new store to serve the fast growing Fullerton field in Andrews County, Texas. The store is being managed by W. K. Mills.

The Odessa branch store is now under the supervision of H. J. Moon. L. L. Talley is West Texas district manager.

Holds Sales Conference

Members of the Oil Center Tool Company sales staff held a three-day conference, June 7 to 10, at the company's plant on Airline Drive, Houston, Texas. Several new products and improvements in well completion methods were demonstrated to the group.

Addresses N. Y. Nomads

The Honorable Herbert Hoover, former president of the United States, addressed the semi-annual meeting of the New York Chapter of Nomads recently. Hoover's talk, consisting partly of replies to questions submitted by members of the organization, was an off the record discussion; however, he revealed a comprehensive knowledge of the international oil situation and an appreciation of the oil industry's problems in his remarks.

The toastmaster was John M. Crawford, director of American Petroleum Institute and one of the oldest living Nomads. Hoover's comments were heard by approximately 250 oil company executives and members of the New York, Los Angeles, Tulsa, and Houston chapters of Nomads.

New Standard President

EUGENE HOLMAN

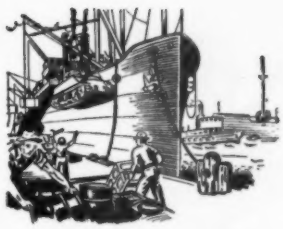
Eugene Holman, a vice president of the Standard Oil Company (N.J.) was elected president of that company to succeed Ralph W. Gallagher, who was made chairman of the board. Gallagher, elected president of the company on January 6, 1943, to fill the vacancy created by the death of W. S. Farish, will remain as chairman of the executive committee. The office of the chairman of the board has been vacant since January, 1943.

Frank W. Abrams, a member of the board of directors since 1940, was elected a vice president. James C. Anderson was appointed comptroller to succeed Thomas C. McCobb, who will continue as a director of the company. All other officers of the company were re-elected.

Wins Third Award

The Lufkin Rule Company, Saginaw, Michigan, for the third time has won the Army-Navy production award for meritorious service in the production of measuring tapes, rules, and precision tools. This permits the company to add the second white star to its Army-Navy "E" flag.

HOW MARINE WINCH Clutch Developments HELP DESIGN More Powerful PIPE LINE BOOMS



Your new and improved products will benefit from the latest war-tested clutch and power take-off developments for handling heavy and unwieldly loads, if you put your power transmission problems up to our engineers. They are ready to contribute their more than a quarter century of clutch building experience toward improving your post-war product designs and taking the kinks out of your production lines. By sending your specifications to us now, your requirements will be met without unnecessary delay when reconversion starts.

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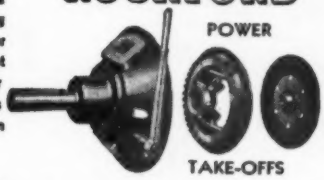
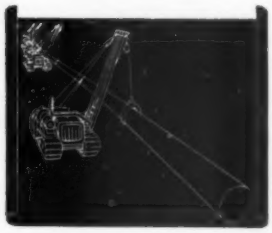


SEND FOR THIS HANDY BULLETIN ON POWER TRANSMISSION CONTROL

It tells and shows how ROCKFORD CLUTCH and POWER TAKE-OFF applications are saving time, power and money in oil field equipment and a wide variety of industries. Gives capacities, dimensions and specifications.



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We will gladly send you a reprint of an article dealing with this subject if you will use the coupon below.

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Tube Borium Keeps 'em digging

STOODY TUBE BORIUM* KEEPS DITCHER TEETH SHARP ...ELIMINATES FREQUENT SHUT-DOWNS FOR TOOTH CHANGES...CUTS REPLACEMENT COSTS UP TO 75%

The two ditcher teeth pictured above were used on the same machine and operated under identical conditions.
The unprotected tooth at the top had to be sharpened every three days and was too short for further service after six sharpenings.
But the Borium-protected tooth at the bottom operated for 40 days and wore only ½". It was simply resharpened in the forge, retipped with Tube Borium, and put back on the ditcher for another 40 days' service.
Before the tooth was finally worn out, it had operated a total of 120 days!
Tube Borium makes such savings possible because the deposits represent the ultimate in wear resistance and the ability to cut hard earth formations.

*Stoody Tube Borium is supplied in rods of ⅛", 5/32", ¼" and ⅜" diameters and is available for either oxyacetylene or D.C. electric application. Prices and specifications are yours for the asking.

These tungsten carbide particles do not melt when tube is applied but are held in suspension in a mild steel matrix forming a deposit resembling coarse sandpaper.

Send for free booklet on TUBE BORIUM, showing sizes and styles of rods and recommended methods of application.

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Stop wear... Eliminate Repair

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